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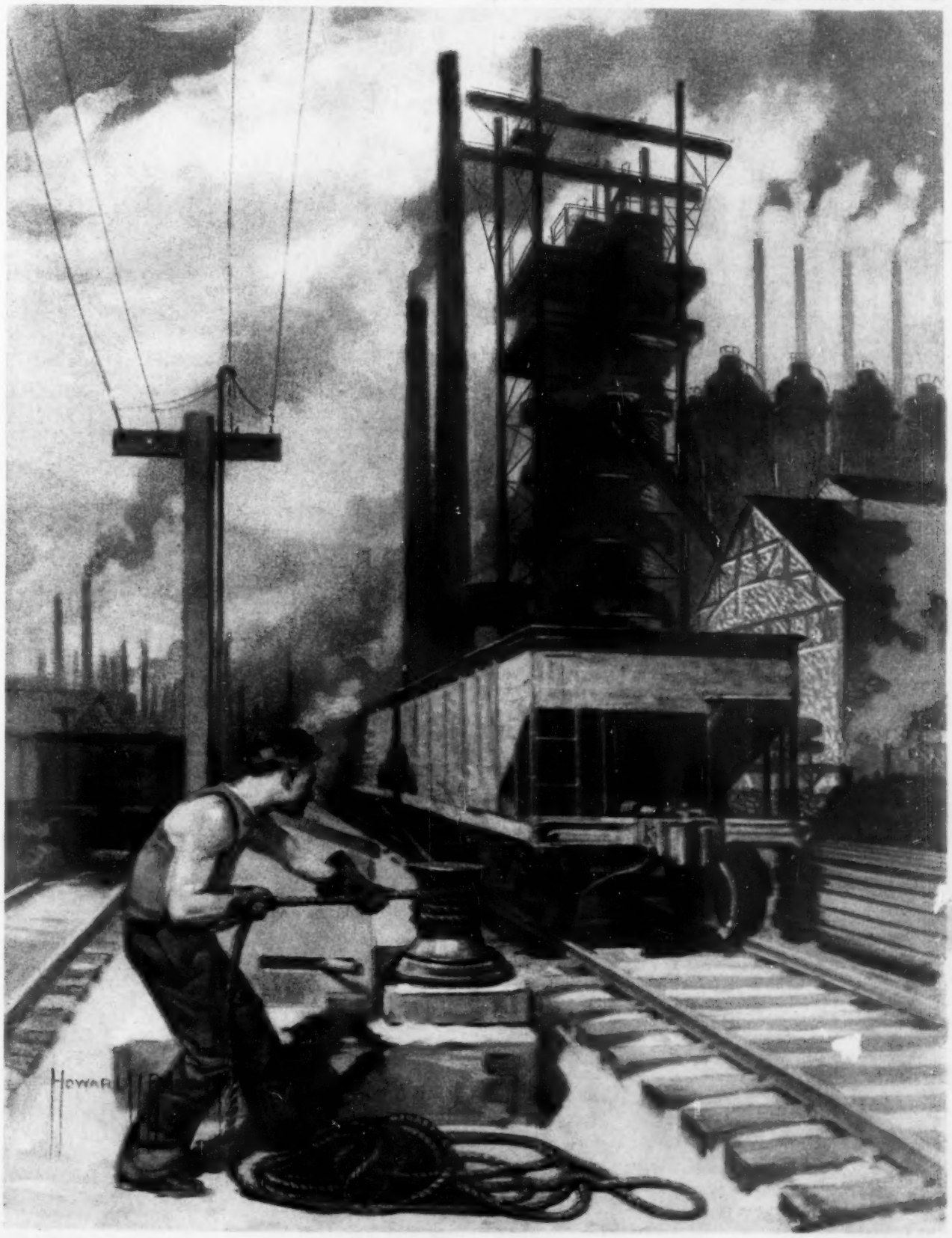
SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS



GETTING ALONG WITHOUT THE SWITCHING LOCOMOTIVE.—[See page 625]

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WHITE *has the* OWNERS

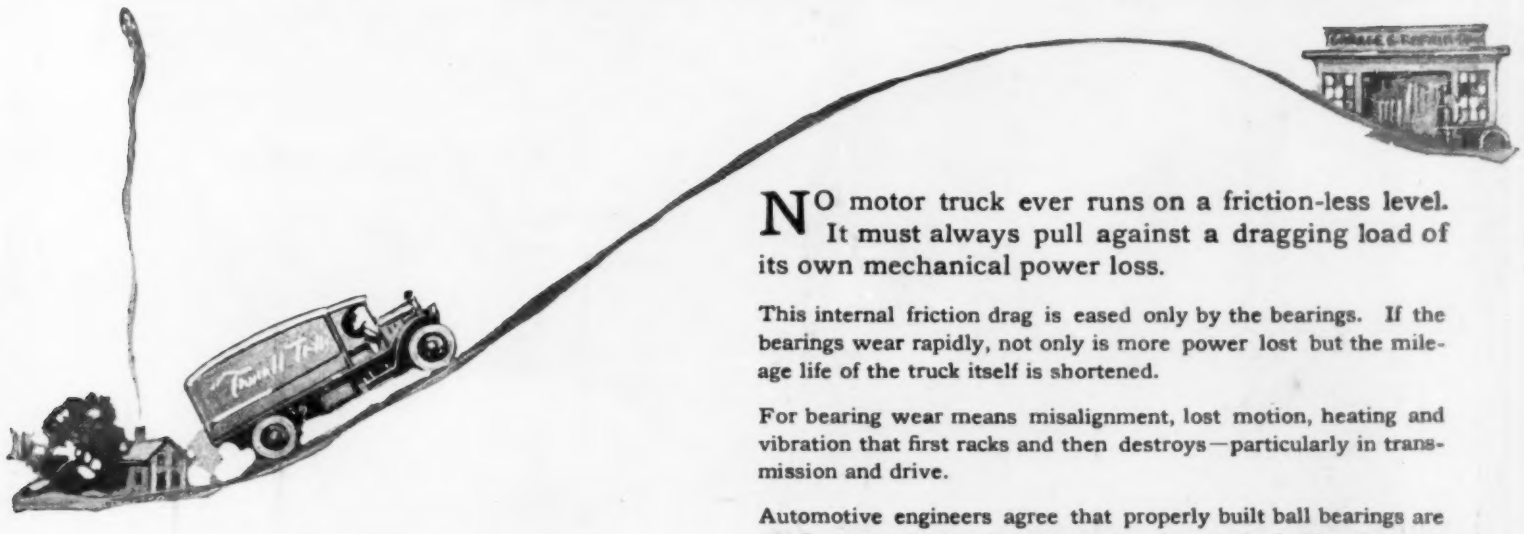
THE real merit of a motor truck is strongly reflected in its owners. The Annual Roll Call of White fleets in actual service is graphic proof of the most remarkable truck ownership in America, as remarkable for the quality of that ownership as for its extent and steady growth from year to year.

The Roll Call, including only owners of 10 or more White Trucks, lists 350 concerns with a total of 12,674 Whites. All together there are 3,691 White Fleets comprising 40,919 trucks exclusive of single-truck installations.

Behind it all there is one decisive reason: White Trucks do the most work for the least money.

THE WHITE COMPANY
CLEVELAND

Over the Hill— to the Repair Shop



NO motor truck ever runs on a friction-less level. It must always pull against a dragging load of its own mechanical power loss.

This internal friction drag is eased only by the bearings. If the bearings wear rapidly, not only is more power lost but the mileage life of the truck itself is shortened.

For bearing wear means misalignment, lost motion, heating and vibration that first racks and then destroys—particularly in transmission and drive.

Automotive engineers agree that properly built ball bearings are the longest wearing bearing made. In proof of this, they are without exception designed into the chassis of the leading truck manufacturers and at points of greatest possible wear.

In S K F and Hess-Bright ball bearings we have not only developed this ball type of antifriction bearing to its highest perfection, but we have further established a scientific research and engineering organization that is shouldering automotive manufacturers' bearing problems. We are endeavoring to serve American industry through this contribution to the building of better trucks.

Manufacturers are invited to avail themselves of this freely offered co-operation.

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The S K F Research Laboratory where friction problems are solved.

The New Packard Basis of Rating was Established by Absolute Transportation Facts revealed by more than 7000 Monthly National Standard Truck Cost System Reports, covering a period of Two Years

Why Packard Discarded "Ton Rating" for Packard Trucks

REASONING as *transportation engineers,* the Packard Company has believed for years that the arbitrary factory "ton rating" system was bound to become obsolete as soon as sufficient facts on transportation could be known.

These facts are now at hand—made available through more than 7000 Monthly National Standard Truck Cost System Reports, covering a period of two years.

These reports confirm what Packard has so long foreseen—the fallacy of rating a truck simply on the tonnage capacity of the chassis and engine under normal conditions.

They have proved again and again the sound Packard practice of rating a truck with *all* the transportation factors in mind—character of roads, grades to be met, speeds to be maintained, and the chances of overload, etc.

COMPARE a Packard Size G, Model E, Truck developing nearly 6700 pounds' traction at rear wheels and able to pull a 28 per cent. grade on low gear; with the typical "6-ton truck," developing less than 4700 pounds' traction, and able to pull only a 20 per cent. grade!

The Packard frame both strong and flexible—made of rolled channel steel, not pressed steel.

Packard *solid tired* trucks governed at 11, 13, 15, 18 miles per hour, by the Packard transportation expert in touch with the actual job.

Today, as always, Packard is selling *transportation.*

HEREAFTER each Packard Truck will be designated by *size* and *model.*

The rating will be made on the ground, *for the job,* by the local Packard engineer—selected for what it will do in the individual customer's business, and with all his *actual conditions* in mind.

"Ask the Man Who Owns One"

PACKARD MOTOR CAR COMPANY, *Detroit*

SEVENTY-SIXTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXXII.
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Crystals That Speak

By Harry A. Mount

ONE of the weirdest of our scientific "toys" is the "speaking crystals" developed during the past three years by A. McLean. Nicolson, a New York scientist. These are simply large crystals of Rochelle salt, specially grown and treated, with which two electrical contacts are made, one about the girdle of the crystal and another on the ends. If the crystal is held under compression between a pair of aluminum plates and twisted by the hands, it gives off an electric charge during the time it is stressed. This charge is easily measurable and depends on the stress on the crystal, being limited only by the breaking point of the salt. Potentials as high as 500 volts have been obtained in the form of alternating currents measurable with a thermocouple.

Likewise, when an electric current is applied to the crystal, it twists or vibrates and can be made to give off a sound audible for several hundred feet. In this connection it can be used with good results as a loud-speaking telephone, or to replace a microphone transmitter.

When the crystal is to be used for this purpose, a cylindrical diaphragm is wrapped around the crystal and is twisted so as to form oblique corrugations on its outside surface. This cylindrical diaphragm is fastened to the two plates by metal rings. A number of substances have been tried for the diaphragm, but the most satisfactory is a good grade of bond paper.

Vibrations imparted to the diaphragm, as by speaking near it, are transmitted to the crystal with a twisting motion. The crystal then gives off an alternating current, and if this be conducted to wireless telegraph head receivers of high resistance, the voice of the speaker is plainly audible. So clear is the reproduction, in fact, that ordinary breathing or a whisper can be heard. The resistance within the crystal is very high, yet as many as two hundred receivers of 12,000 ohms each have been operated from one crystal.

If an audion amplifier can be introduced in the circuit, the effect, of course, is much strengthened. Now, if a second crystal, treated exactly like the crystal used as a transmitter, be substituted for the wireless receiver, it becomes a loud-speaking telephone. An interesting phenomenon observed in two crystals thus connected through an amplifier, is that they may "howl" at each other. The transmitting crystal catches some sound and sends it to the loud-speaking crystal. The second crystal sends it back to the first as sound waves, and it is returned again through the amplifier. A screechy howling is set up that will be kept up until interrupted in some way.

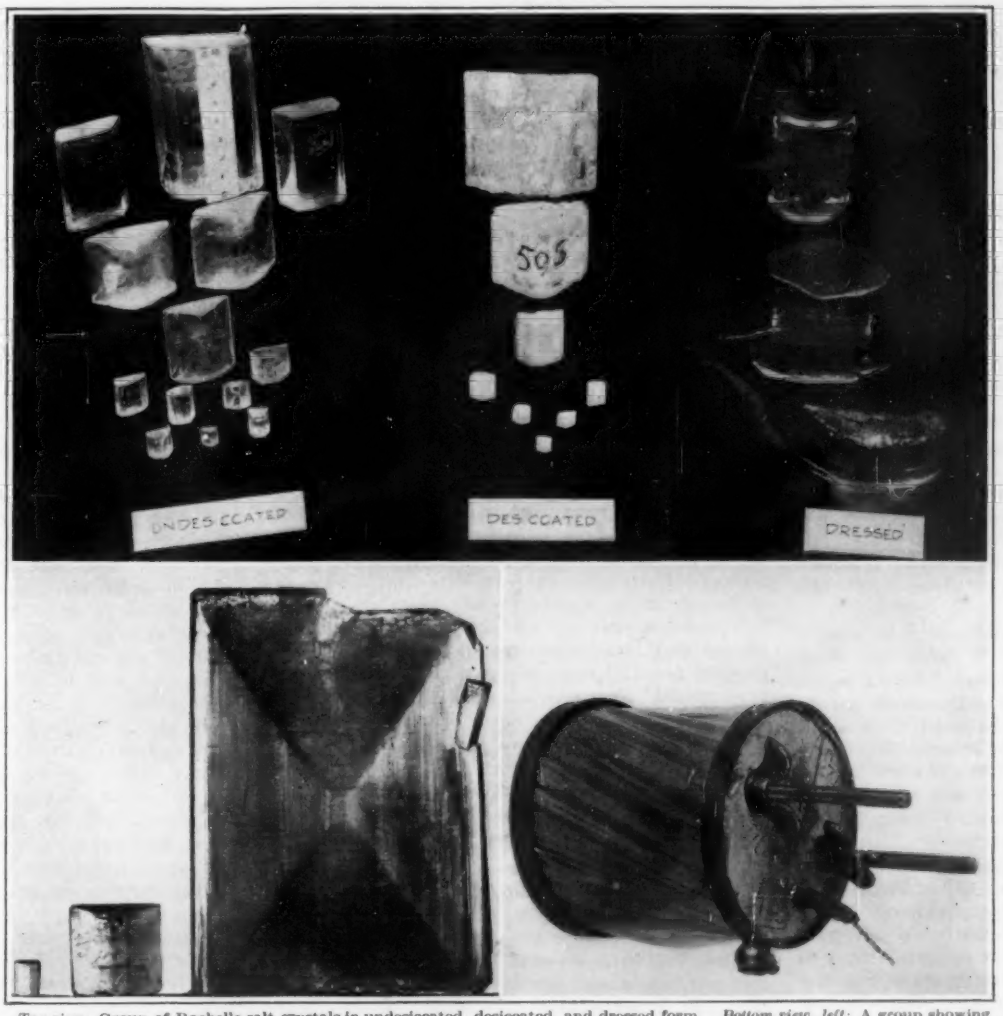
Another interesting application is to the phonograph. A metal plate is placed under one end of the salt crystal and a phonograph needle is attached to the plate. The phonograph horn is detached and the salt crystal takes its place. The vibrations of the needle are transmitted to the salt and the music is audible in wireless head-sets. By using an amplifier and a loud-speaking crystal, the music becomes audible.

Mr. Nicolson believes the reproductions he has been able to obtain from the phonograph, are more perfect than those obtained by purely mechanical means.

So far, little experimentation has been done with any other substance than Rochelle salt, but Mr. Nicolson believes even a better crystal may be found. The so-called "piezo-electric" effect of certain asymmetric crystals was first observed by J. and P. Curie. They obtained very small electric charges by simply compressing the crystals. Other investigators have used slices of the crystals. But by far the best results have been obtained from the whole crystal of Rochelle salt. These crystals are grown very rapidly, so that an intermolecular strain is set up within the crystal. This heightens the effect.

After the crystals are grown, they are desiccated in alcohol and then dehydrated in an oven. The crystals are then ready for use. It has been noticed that their effectiveness improves with age.

No commercial application of the crystals has yet been made.



Top view: Group of Rochelle salt crystals in undesiccated, desiccated, and dressed form. *Bottom view, left:* A group showing crystal growth. At the left is a nucleus used in starting the growth in a super-saturated solution of Rochelle salt. The center crystal, weighing about an ounce, is the most practical size. The large crystal is the largest so far produced and weighs nearly two pounds. The crystals are shown about one-third actual size. *Bottom view, right:* The "speaking crystal" surrounded by a cylindrical, twisted diaphragm of paper and ready to act as a transmitter or receiver.

How Rochelle salts can be applied to microphonic purposes in experimental, telephonic and other work

Theory of Lubrication

FAMILIAR as we are with the necessity of lubrication for the working parts of machines, it cannot be said that we possess any very complete or convincing theory explaining how a lubricant operates, or why some oils make good lubricants while others do not lubricate at all. A paper recently read before the Physical Society of England by Mr. R. Mountford Deeley throws an interesting light on some of these problems, from which it appears that a study of colloidal chemistry may provide us with the complete theory for which we have hitherto looked in vain. The true lubricant is, chemically considered, an unsaturated compound—that is to say, it has certain unsatisfied residual affinities which enable it to enter readily into combination or extremely intimate relationship, with other substances; and the ideal lubricant, for any given kind of surface, is that which will enter into the most intimate combination with that surface, or in other words, will be most powerfully absorbed by it.

This consideration led to an ingenious new method of testing the lubricating properties of oils. Hitherto such tests have been made by interposing between two surfaces a film of appreciable thickness of the oil to be studied. The new idea was to bring the surfaces of two metals into absolute contact without leaving space between them for any appreciable film of lubricant. In these circumstances, if the two surfaces be rubbed with the lubricant which is to be tested, and then brought into contact and tested, it is clear that, whatever the result may be, it will be due to the relation between the oily metals, and not to the viscous flow of a film of liquid, seeing that there is no liquid to flow. Of course only a colloid will be available without the formation of a surface film.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

The Scientist and His Definitions

DISCUSSION of the Einstein doctrines is a foregone conclusion in any gathering of laymen possessing some scientific attainments, and always such discussion founders on the rock of a disputed definition. One insists on having time or distance defined before he will proceed; another reads into the structure of science, as definitions, certain ideas, common to all of us because derived from our perceptions of Euclidean space and Newtonian mechanics; usually there will be some one present who holds the somewhat iconoclastic viewpoint of modern mathematical science toward the definition. In such a gathering, it is distinctly in order to ask: "What and why is a definition?"

Now we do not speak here in terms of dictionary definitions. These have for object the eminent necessity of explaining the meaning and use of a word to some one who has just met it for the first time. It is easy enough to do this, if the doer possesses a good command of the language. It is not even a matter of grave concern that the words used in the definition be themselves known to the reader; if they are not, he must make their acquaintance too. Dr. Johnson's celebrated definition of a needle stands as perpetual evidence that when he cannot define a simple thing in terms of things still simpler, the lexicographer is forced to define it in terms of things more complex. Or we might demonstrate this by noting that the best dictionaries are driven to define such words as "and" and "but" by using such complex notions as are embodied in "connective," "continuative," "adversative," and "particle."

It is otherwise with the scientist who undertakes to lay down a definition as the basis of further procedure in building up the tissue of his science. Here a degree of rigorous logic is called for which would be as superfluous in the dictionary as the effort there to attain it would be out of place. The scientist, in building up a logical structure that will withstand every assault, must define everything, not in terms of something which he is more or less warranted in supposing his audience to know about, but actually in terms of things that have already been defined. This really means that he must explain what he is talking about in terms of simpler ideas and simpler things, which is precisely what the lexicographer does not have to worry about. This is why it is quite trivial to quote a dictionary definition of time or space or matter or force or motion in settlement of a controversy of scientific or semi-scientific nature.

But the scientist who attempts to carry out this ideal system of defining everything in terms of what precedes meets one obstacle which he cannot surmount directly. Even a layman can construct a passable definition of a complex thing like a parallelopiped, in terms of simpler concepts like point, line, plane and parallel. But who shall define point in terms of something simpler and something which precedes point in the formulation of geometry? The scientist is embarrassed, not in handling the complicated later parts of his work, but in the very beginning, in dealing with the simplest concepts with which he has to do.

Suppose a dictionary were to be compiled with the definitions arranged in logical rather than alphabetical order; every word to be defined by the use only of words that have already been defined. The further back toward the beginning we push this project, the harder it gets. Obviously we can never define the first word, or the second save as synonymous with the first. In fact we should need a dozen words, more or less, to start with—God-given words which we cannot define and shall not try to define, but of which we must agree that we know the meanings. Then we have tools for further procedure: we can start with, say, the thirteenth word and define all the rest of the words in the language, in strictly logical fashion.

The scientist does just this. Euclid in writing the first geometry did not have this viewpoint. He defined his simplest things—his point and line—by reference to less simple ideas like those of distance, position and magnitude. Apparently it never occurred to him that these were less simple, that they satisfied him merely because they were nonmathematical to a certain extent. The modern geometer falls in with Euclid when he writes an elementary text, satisfying the beginner's demand for apparent rigor by defining point and line in some fashion. But when he addresses to his peers an effort to clarify the foundations of geometry to a further degree of rigor and lucidity than has ever been attained, he merely exerts every energy to select his undefined terms in such a way that there shall be a minimum number of them. Whatever their number and whatever they are, we must accept them, agree that we know what they are, and that they possess certain properties which are likewise assumed—again to a minimum number. Then the body of geometry follows as a necessary consequence. And a geometer trying to improve upon Hilbert's scheme for the foundations of geometry would devote his entire attention to the effort to dispense with one of Hilbert's undefined elements or one of his assumptions, by showing that the element could be defined in terms of the others, or the assumption proved from the others. If he failed in this effort, he would not conclude that the element did not exist or that the assumption was false, however; he would merely conclude that Hilbert had chosen wisely the things that he would not define or prove.

So it is with all science. Mathematics, physics, chemistry—in the large and in all their many minor fields—all these must start somewhere. Instead of deceiving ourselves as to the circumstances surrounding their start, we prefer to be quite frank in recognizing that they start where we decide to start them. If we don't like one set of undefined terms as the foundation for our cosmogony, by all means let us try another. But always we must have such a set. And if we are not to admit time and space and distance and force and motion to that set, it must be on the one ground that satisfactory definitions of these can be given in terms of something that is simpler and more fundamental. Next time some one asks you to support an argument by defining space or matter, remember this; or if you hear quoted the definition of (Newtonian) time as "the uni-directional linear continuum" and if this means anything to you, remind yourself that it is not a definition at all, but merely the best description and discussion that has yet been given of this concept.

The Credit Account

IT is often perfectly plain that a certain field of invention or research holds sure promise of reward. But ordinarily we even then hesitate to embark upon any undertaking which savors of accelerating the slow and dignified pace of scientific progress. We excuse this slow-footed advance in the technical arts by pretending that scientific progress must necessarily be slow, accompanied by much feeling of the way, much gradual development, much of the painful process of discovery by trial and error. But the real root of the trouble is that by far the greatest part of the world's inventing has always been left to chance. There are always so many ways in which money can be put to work that it seeks the line of least resistance. The financing of an organized attack upon the outstanding technical problems of the age is not a proposition that attracts the financier. He wants to know what guarantee he has that these problems will be solved, and solved to his profit; and when such a guarantee is not forthcoming, he puts his money in a mine or a well or a factory.

Mars, however, is a liberal paymaster. He knows what he wants; he wants it when he wants it; and he does not have to make his operations show a profit, so he can well afford to spend freely in twenty directions in the expectation of getting some slight return from one of these quarters. Hence it is that the moment the nation goes to war every resource of science and invention that can possibly be brought to the aid of the fighters is eagerly seized upon. Neither effort nor expense is spared in the squeezing of the last drop of utility out of every idea that presents the least promise. The result is not merely the furthering of the fighting arts, but the incidental development of many things of lasting value in time of peace. Under the stern urge of necessity, the deliberate pace of scientific investigation and mechanical improvement is vastly accelerated, and the normal progress of a century may be condensed into four or five years of intensive driving effort.

Thus it has been with the great war so recently concluded. It is far too early to write the technical history of this conflict, for we have by no means seen the last of the peace-time application of war's ideas—nor, doubtless, the most striking ones either. But it is not at all too soon to point out that this war will in the end show more credits to offset against its debits than any of its predecessors.

To commence with the obvious, it needs no argument to establish that the war made the airplane what it is today. Neither the time nor the money nor the desperate risks to life and limb that have been so freely contributed to the cause of aerial warfare would have been forthcoming in support of the orderly peace-time development of the art.

Then we have the vast reflexes of aviation, felt chiefly in the automobile industry and in aerial photography. The maker of cars and trucks has learned much from the behavior of the airplane engine, representing as this does the very highest type of internal-combustion motor. And the art of taking pictures from the air has already spread to all quarters of the globe, and made itself useful and indispensable to surveyor, real estate man, mapmaker, farmer, forester—who shall say where the limit lies?

The only exaggeration which could possibly be made in estimating the part played by the war in the development of our present commercial wireless telephony would be to credit the existence of this art to the war. This would be an error; nothing else we can say would depart from the truth.

The war-time necessity for learning the movements of a concealed enemy gave rise to the development of the hydrophone on sea and the geophone on land. The former is being applied commercially to determine the depth of water, thus locating the submarine enemy of navigation that is always with us. The latter has come into similar use in connection with mine-rescue work and, indeed, any other work involving subterranean exploration from the surface.

Even such a specific war invention as poison gas is not without its peaceful applications—peaceful, that is, as between men, but warlike enough as regards the insect pests and the rats against which this new weapon has been directed with success.

Then there is the track-layer, invented nobody has been able to discover how long ago, re-invented over and over again, never able to advance beyond the rank of a mechanical curiosity until the war made it vital to try everything that stood a chance of success. What position the track-layer holds in the agriculture of last year and this we need not specify, nor repeat that this is all to the credit of the war.

The charges against the war are heavy—heavier than can ever be met. Germany is said not to have recovered measurably from the Thirty Years' War for over a century, and it seems not unlikely that a similar period may apply to the ravages of the late conflict. But this is all the more reason why we should not blind ourselves to the benefits which can be seen to have followed in the train of the war, and to exert every effort to make these slight offsets of the debit account as heavy as our persistence and ingenuity can make them.

Engineering

Hollow Bricks in England.—A new brick that has recently been introduced in England is nearly five times as large as an ordinary brick, but in comparison is much less heavy and is easily handled. The lighter weight results from the hollowing out of the brick to provide air layers. By the shaping of the ends the existence of joints running all the way through the wall is avoided. The brick is, as a rule, made of one part of cement and four parts sand by simple hand machinery. Three men can make enough bricks in a day to build 400 to 500 square feet of wall. A further economy is effected by the manner of laying the walls, inasmuch as the ends and bottoms of the bricks need only be dipped in a thin lime mortar mixed with a small amount of cement. If laid in the usual way the air channels in the bricks would become filled.

Belfast's New Reservoir.—The city of Belfast in Ireland is about to start construction on a storage reservoir in the Silent Valley above Kilkeel. This reservoir will call for a big dam which will require seven years to build, and with the contingent works will probably cost not less than $5,000,000, but when made the reservoir will store 3,000,000,000 gallons of water for summer use in the city. The fifteen existing reservoirs have a less capacity by 100,000,000 than this artificial lake which is to cover the center of the Silent Valley. The Kilkeel River will be intercepted at a point about 450 feet above sea level. A dam will be thrown across the mouth of the valley, and the mountain slopes will form naturally the other sides of the new basin. The dam will be 1,500 feet long on the top bank line, and its height from the river bed will be 90 feet.

New Suggestions as to Continuous Rail.—The continuous rail is becoming one of the problems of railroad work, says Prof. C. F. Keel, director Swiss Acetylene Society, in an article in the *Revue de la Soudure Autogene*. The present practice of bolting rails together causes discomfort to passengers and fatigue in the metal. Efforts have been made to realize the ideal of a continuous rail by means of electric, oxyacetylene and thermit welding. The author gives the results of tests made in welded joints and describes a new method of making such joints. This is as follows: The head and foot are both welded; but the web is cut out by means of a torch, because it was found that when the weld extended through the web it was difficult to preserve the alinement of the rails. In the case of rails already laid, the author recommends that the base, which is subjected to the greatest strains, be welded first. He proposes to continue the use of the ordinary fish-plates to aid in maintaining the alinement. As welding rod he uses a metal as nearly like that of the rail as possible. These rods contain some silicon and some manganese. A flux having a base of sodium carbonate has been used.

Treating Concrete Surfaces.—Early attempts at treatment—apart from paneling, which gives some relief—consisted in "rendering" the surfaces with a thin coat of cement mortar, which is, however, liable to scale off later. By placing the mortar face at the same time as the concrete backing, continues *Engineering World*, a removable metal plate first separating the two, some improvement was effected. Variety in surface appearance was also achieved by the use of different kinds and colors of coarse aggregate on the surface mixture, these being fully exposed to view by scrubbing the green work with stiff brushes and water. Dilute hydrochloric or sulphuric acid may then be used to bring out the color and texture satisfactorily. Bush-hammering, crandalling, and sand-blasting have also been practised. The textures resulting vary considerably and may be used with effect. Surfaces may also be finished by rubbing with carborundum or cement bricks. The result is a fine smooth finish of grayish white color. Tile laid in the concrete surface has been tried with some success. Forms have also been used having horizontal triangular grooves to give surface relief. This is said to be effective for such structures as large railroad bridges. Costs for different methods are given for the year 1915. Methods of carrying out work of this description are detailed, with the age of work, in days, at which it may best be done.

Science

A Census of Special Libraries.—Every scientific worker has probably felt at times that his studies would be facilitated if he had some means of locating the most important collections of literature relating to a particular subject. A step in the direction of satisfying this need has been taken by Mr. W. F. Jacob, librarian of the General Electric Company, Schenectady, who has issued a circular with a view to gathering information concerning the special libraries of the country. A "special library" is defined as "a good working collection of information upon a specific subject or field of activity; it may consist of general or even limited material serving the interests of a special clientèle; and preferably in charge of a specialist trained in the use and application of the particular material." Such libraries may be classified as financial, business, legal, engineering or technical, institutional, municipal, reference, agricultural, etc., etc.

To Study Fatigue Phenomena in Metals.—During the war the National Research Council organized a committee to study the failure of crankshafts of airplane engines, of welded ship plates and of other metal parts of machines under the repeated loads applied to them in service. The work of this "Committee on Fatigue Phenomena in Metals," which has been under the direction of Prof. H. F. Moore, of the University of Illinois, is now to be continued on a very much enlarged scale by a new organization under the joint auspices of the Engineering Foundation, the University of Illinois Engineering Experiment Station, and the National Research Council, the expenses being met mainly by the income of the fund given to the Engineering Foundation in 1915 by Mr. Ambrose Swasey for promoting research relating to engineering. Prof. Moore will continue to direct the undertaking, which is expected to extend over a period of two years.

Progress of the Cotton Boll Weevil.—The U. S. Department of Agriculture has published a chart showing the progress of the cotton boll weevil in the United States during the 28 years since it crossed the Rio Grande from Mexico near Brownsville, Texas. During the year 1919 it infested 34,500 more square miles of our territory. It is now approaching the northerly limit of cotton production, and has reached it at one point. The most important development of last year was the very rapid advance northward along the eastern portion of the line in Tennessee, Georgia, and the Carolinas. West of the Mississippi there was little change during the year, while a slight recession occurred across Arkansas. In all infested states but two the pest gained ground. About 115,000 square miles of cotton-growing territory still remain uninfested. Beyond the limits of our southeastern cotton belt, the weevil occurs in the mountains of Arizona on a wild cotton plant, but it has not yet attacked cultivated cotton in that state. It was recorded in Eddy County, New Mexico, in 1918, but evidently failed to become established in that region, and no specimens were found there in 1919.

Sunshine in the United States.—Whether a place enjoys a sunny climate or the reverse is a matter of much economic importance. Statistics of the duration of sunshine in the different parts of the world are, however, less abundant than those of temperature, rainfall, and some other meteorological elements, for the reason that sunshine-recorders are comparatively scarce, on account of their delicate character and the amount of skill required to keep them in operation and tabulate their records. In the United States most of the 200 regular stations of the Weather Bureau have these instruments, but they are rarely found at the far more numerous volunteer ("coöperative") stations. Mr. J. B. Kincer, of the Weather Bureau, has just published in the *Monthly Weather Review* a valuable analysis of the available sunshine records of this country. He presents charts and graphs showing for all parts of the United States the mean solar time of sunrise and sunset; the average length of the day, sunrise to sunset, for different seasons of the year; the average for each month in the year, of the daily amounts of sunshine, in hours; the seasonal and annual amounts in percentage of the maximum possible; the yearly percentage of clear, partly cloudy and cloudy days; and various other data.

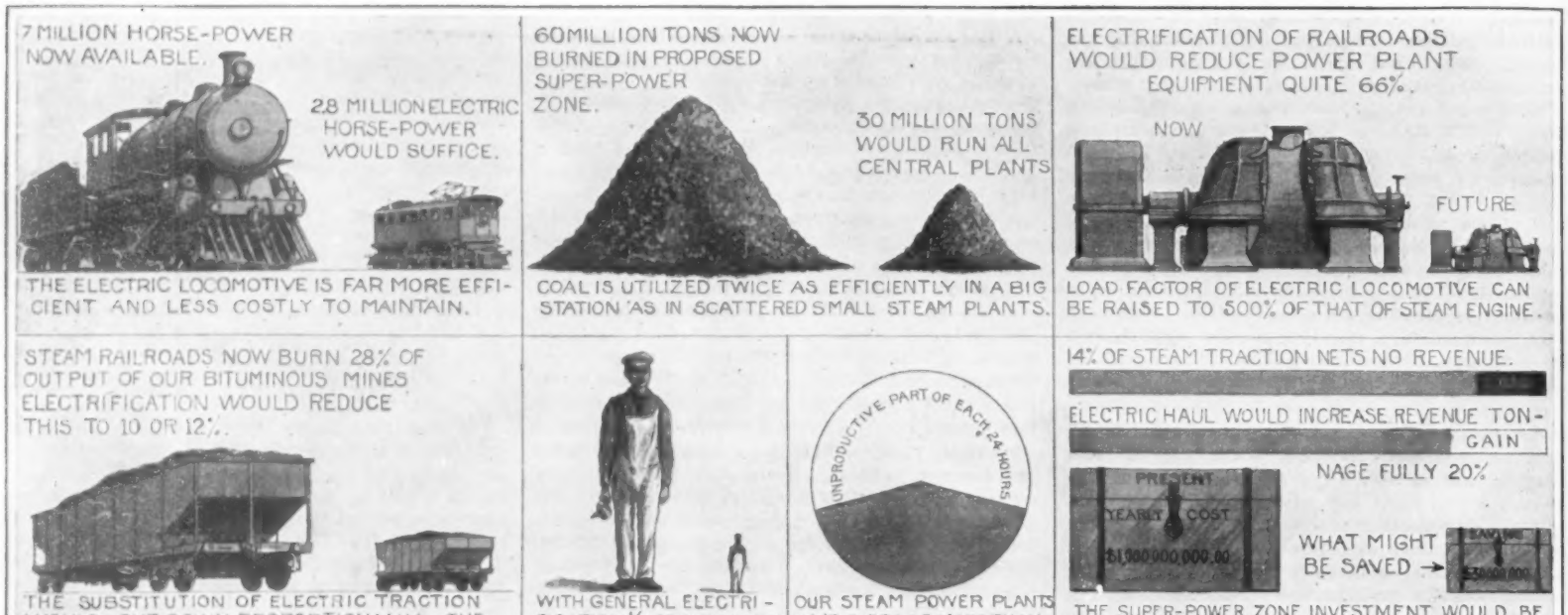
Automobile

Auto Axle Construction.—A true semi-floating axle should be of such form that the axle may be readily withdrawn without necessitating the complete disassembly of the rear construction. The axle is semi-floating to a degree, however, when the differential gear is carried by bearings which are outside of the differential case bosses instead of bearing directly on the axle shaft, as is the case with light axles of such cars as the Ford. The three-quarter floating axle is a design in which the axle shaft is subjected only to torsional strains or to a twisting action due to the power applied to drive the car. The wheel bearing is mounted on the axle housing instead of inside of that member. This brings the strain due to the weight of the car on the non-rotating axle housing instead of on a rotating shaft which must carry the car weight as well as power in light car axles.

Forming Rod Ends.—Many of the minor control rods used in an automobile such as used for advancing the timer, manipulating the throttle or working the muffler cutout are simple steel rods with the ends bent over to be pushed through the eye of the levers they connect and held from backing out by a split pin. A simple method of making these rod ends involves the use of a block of steel drilled with three or four holes to conform to the sizes of rod ends most generally used. It is well to have the holes about one sixty-fourth inch larger than the rod size. The writer would advise making holes, one-eighth inch, three-sixteenth inch, quarter-inch and five-sixteenth inch in the block. When making the rod end, the block is held in the vise and the rod, which is either Norway iron or mild steel is thrust into the block to the desired depth and then bent over with a hammer. Bending the rod should be done slowly and with as much care as possible and the rod should preferably be heated to a red heat before bending if a sharp bend is required.

Simple Remedies for Burns.—The motorist working around his car is apt to burn his hand on a hot exhaust pipe unless very careful, if working on a hot motor. The most generally used covering for burns is picric-acid gauze. This is ordinary sterile gauze which has been saturated with one-half to one per cent solution of picric-acid. It has this advantage—it is clean and ready for use. Moisten the picric-acid gauze with clean water and put it over the burned surface. Over the gauze place a layer of absorbent cotton then apply a bandage to hold in place. Carron oil, which is a mixture of equal parts of lime water and linseed oil, is often used, and is very good. It is applied as follows: Take a piece of sterilized gauze large enough to cover the burned surface; saturate the gauze with carron oil and cover the burn. Dress with absorbent cotton and cover with a bandage. Vaseline, sweet oil, olive oil and balsam oil are all good dressings. If nothing better is at hand dissolve some bicarbonate of soda in sterilized water. Gauze wrung out of this and spread over the burn will give relief.

Ampere-Meter Indications of Trouble.—A short circuit will be indicated by the position of the ampere-meter pointer. Always note the position of the index hand of that instrument when the car is stopped. With the engine at a standstill and no lamps burning the hand should point to zero. If it does not the ampere-meter is either out of calibration or there is a leak of current from the battery at some point in the wiring. To ascertain if the ampere-meter is correct, uncouple one of the battery terminals of the lighting system. Obviously, if the hand swings to zero, the trouble is leakage of current, which should be immediately corrected after the trouble is located. If the index does not point to zero when the battery terminal is disconnected, the instrument is out of calibration, and while this does not affect the operation of the system it should be taken into account when reading the ampere-meter. If the engine backfires when the ignition is interrupted and it makes one or two revolutions in the reverse direction, the ampere-meter pointer may be found at the extreme of the scale on the discharge side. This is caused by the circuit breaker contact being held closed and means a short circuit of the battery through the generator winding. This must be corrected at once by momentarily disconnecting one of the generator wires or starting the engine.


7 MILLION HORSE-POWER NOW AVAILABLE.
28 MILLION ELECTRIC HORSE-POWER WOULD SUFFICE.
THE ELECTRIC LOCOMOTIVE IS FAR MORE EFFICIENT AND LESS COSTLY TO MAINTAIN.
60 MILLION TONS NOW BURNED IN PROPOSED SUPER-POWER ZONE.
30 MILLION TONS WOULD RUN ALL CENTRAL PLANTS
COAL IS UTILIZED TWICE AS EFFICIENTLY IN A BIG STATION AS IN SCATTERED SMALL STEAM PLANTS.
ELECTRIFICATION OF RAILROADS WOULD REDUCE POWER PLANT EQUIPMENT QUITE 66%.
NOW
FUTURE
LOAD FACTOR OF ELECTRIC LOCOMOTIVE CAN BE RAISED TO 500% OF THAT OF STEAM ENGINE.
STEAM RAILROADS NOW BURN 28% OF OUTPUT OF OUR BITUMINOUS MINES ELECTRIFICATION WOULD REDUCE THIS TO 10 OR 12%.
THE SUBSTITUTION OF ELECTRIC TRACTION WOULD CUT DOWN PROPORTIONALLY THE COAL CAR TRACKAGE
WITH GENERAL ELECTRIFICATION 1/4 OF THE MEN AT MINES, STATIONS & WOULD DO.
UNPRODUCTIVE PART OF EACH 24 HOURS
OUR STEAM POWER PLANTS DON'T AVERAGE MORE THAN 10 HOURS GAINFUL USE DAILY
14% OF STEAM TRACTION NETS NO REVENUE.
ELECTRIC HAUL WOULD INCREASE REVENUE TONNAGE FULLY 20%
GAIN
PRESENT
YEARLY COST
$1,000,000,000.00
WHAT MIGHT BE SAVED →
THE SUPER-POWER ZONE INVESTMENT WOULD BE $1,240,800,000: YEARLY RETURN WOULD BE 24%

Some comparative facts and figures which go to prove the marked economy that would be effected by gathering the various scattered power plants along the middle Atlantic seaboard into one big operating group, as outlined in the accompanying article

Pooling Our Power

Economic Possibilities of the Super-Power Plan

By Robert G. Skerrett

THE gage of a nation's industrial might is the amount of motive energy which it can command for the manifold fields of production and the essential contributory activities. Heretofore, we have maintained our supremacy in manufactured output very largely because of the vast amount of power which we could call into service. Modern nations expend far more energy than the combined muscular ability of their population and beasts of burden. The margin is covered by the employment of mechanical energy in the form of power. To accomplish the work done annually in the United States, or at least the equivalent in such kind as men could perform, would require the labor of three billion hard-working slaves. The use of power gives to each man, woman and child in this country the service equivalent of 30 servants.

It goes without saying that the American workman has behind him in executing his daily task a great deal more motive energy than his kindred toilers abroad; but it is dawning upon our technicists and others, heedful of the way in which we are using up our bounty of raw materials, that the time has come when we must readjust our habits and set seriously about devising means by which we can conserve our fuel resources and make every pound of coal and every gallon of crude oil furnish its fullest measure of potential energy. We cannot achieve this end unless we cut out a good deal of existing lost motion, scattered effort, and bring about coördination in the form of bulk production of power.

DISCUSSION has made it pretty clear that we have been using up, during the past few decades, far more fuel than we should have used, and far more than we dare use in the immediate future if our visible reserves are not to be reduced to the vanishing point. Suggestions of many sorts have been put forward for remedying this defect in our economic procedure, but none of these cures has made much of an impression, either upon the situation or upon the public consciousness. Now is presented a scheme for deliberate and systematic application of the economy of bulk production throughout the power-producing industry—beginning right at the center of that industry, in the great power-consuming zone that centers along the Middle Atlantic Seaboard approximately from Boston to Baltimore. Mr. Skerrett presents in this article the viewpoint and claims of the proponent of this idea, and tells just what he hopes to accomplish in the way of fuel saving by its adoption.—THE EDITOR.

It has recently been proposed by an eminent engineer, backed by the four great engineering societies of the nation and likewise strongly endorsed by certain officials of the Department of Commerce, that we initiate the era of inevitable readjustment by calling into being a super-power zone in the most intensive manufacturing region in the country. That is to say, the section of the Atlantic States extending inland from the coast for a distance of 100 to 150 miles and lying between the northern boundary of Massachusetts and the southern limits of the District of Columbia. That part of America, as Mr. William S. Murray, the originator of the idea, describes it, constitutes the vast finishing shop of the United States and, for that reason, should be thoroughly modernized in the vital matter of power utilization.

Into the factories and shops within the zone described is poured continually a tremendous tonnage of raw or partly prepared material for the purpose of working it into well-nigh innumerable forms ready for its final service or its ultimate consumers. According to the figures furnished as a reason for the super-power plan, it seems that we now have inefficiently active in the zone in question a total estimated machine capacity of 17,000,000 horse-power. Of this, 7,000,000 horse-power is allotted to the railroads, and the 10,000,000 horse-power remaining is devoted to industrial activities. If all of this motive equipment were needed, conditions would not warrant criticism; but it seems that in general the engines are operating with a load factor probably less than 15 per cent of their full capacity!

Put in plain terms, the power plants, mobile and stationary, represent as a rule dissociated efforts to supply individual or limited requirements, and have involved expenditures of many, many millions of dollars in establishing motive units that are much in excess of the demands and are used for comparatively short periods in every twenty-four hours. A good deal of the stationary equipment is in the nature of reserve apparatus intended to guard against breakdown as well as to provide intermittently additional energy to tide over an exceptional peak load or an emergency. In the meantime, this costly apparatus is idle and non-remunerative.

Most of the informed public know that the isolated steam plant is not an economical installation, because each one of these calls for a duplication of supervision and attendance out of proportion generally to the measure of horse-power developed. Again, owing to the more or less moderate or modest nature of the plant, recourse to facilities making for fuel saving is impracticable. It is due to this fact that public-service power stations, distributing energy in the form of electricity, have been erected and have done much towards bringing about the abandonment of steam generation on a so-called small scale for hundreds of industries lying within the reach of the transmission lines of these dominating central plants.

In brief, the central power station is merely another expression of manufacturing methods or quantity output. There is a further gain in this concentration, because it brings to a focus diversified demands and calls for power in large blocks throughout the major part of each twenty-four hours. Therefore, equipment can be operated more nearly approaching maximum capacity; and this fairly sustained activity brings in a commensurate return upon the initial investment.

Now see what this idea involves if we carry it a step further in its logical evolution. Why shouldn't the various central stations within a radius of effective transmission link their systems to trunk lines and thus pool their output of current so that the energy of this electrical reservoir could be tapped here and there and everywhere throughout this far-flung field for the purpose of meeting the shifting multiple needs of divers communities? In a way, this very thing is being done in some parts of the country to the marked benefit of all concerned. More than that, for a given amount of power, a good deal less fuel is required; and to just that extent the transportation of coal and the disposal of ashes is reduced, while the labor charges are materially lowered.

The super-power zone project contemplates joining up all of the big and efficient electrical generating stations, now situated within the section mentioned, as the first move towards bringing about a new era of fuel conservation. Mr. Murray declares that his investigation warrants the belief that the load factor can be raised to 50 and possibly 60 per cent, increasing it three or fourfold, while cutting the annual coal bill down quite one-half—simply because one ton of coal would then do the work which now takes two.

At certain mines in West Virginia, some years ago, there were installed separate steam plants totalling

(*Continued on page 630*)

Two Engines for One

By Herbert T. Walker

WITH the constant increase in the cost of labor, fuel and all material, it has become necessary to utilize every pound of draw-bar pull the locomotive engine is capable of. Until recent years, the tender of a locomotive has been a paying load only in so far as it has served to keep the engine supplied with coal and water; but beyond this it has been a dead weight, and, as many tenders weigh about 175,000 pounds, this is now a serious consideration.

The management of the Southern Railway has been contending with the problem of operating a line having an unusual amount of curvatures and heavy grades, one representing a continuous ascending grade of four per cent for a distance of three miles. A solution of the difficulty has been reached, after much experimental work, by utilizing the cylinders, frames and running gear of old mogul and consolidation locomotives withdrawn from service, and placing them under the tenders of the regular Mikado type of road engines in use on that line.

The first of these "duplex" engines made its initial trip in March, 1915, and since that time a large number of them have been put in service with highly satisfactory results. It appears that the tax on the steam supply from the boiler of the main engine is not excessive, since the duplex engines operate over rolling grades, permitting the steam tender to run idle as opportunity offers. Furthermore, it is found that with the addition of fire-brick arches, feed-water heaters and other improvements to the main engine, there is ample steaming capacity to supply all four cylinders through a period of 50 minutes. By careful research it has been demonstrated that by the use of the steam tender the hauling capacity of a locomotive so equipped is materially increased without complicating its design or in any way interfering with the comfort or convenience of its operators.

A very important feature in connection with this improvement is the fact that many light locomotives which, in the ordinary course would be relegated to the scrap heap, may now have the old boilers removed and the tanks of the standard engines mounted on the old locomotive frames, utilizing the entire engine to get the increased tractive power at very small expense.

The accompanying photograph of one of these duplex engines will give a good idea of their appearance, and a line drawing of the steam tender is added to bring out interesting details.

The general dimensions are: Weight of engine, 367,000 pounds; cylinders, 28 inches diameter by 32 inches stroke; diameter of driving wheels, 57 inches; tractive effort, 71,100 pounds; weight of steam tender loaded, 253,000 pounds; cylinders, 19 inches diameter by 26 inches stroke; diameter of driving wheels, 57 inches; tractive effort, 18,000 pounds; making a total tractive effort of 89,100 pounds for the duplex engine.

The main steam supply to the tender engine is by means of a 3-inch pipe connected to the header of the superheater and extended back along the boiler and under the cab where it is coupled to a pipe having flexible joints leading to the valve chests. To provide an additional supply of saturated steam when working on heavy grades, a small pipe is led from the boiler head to the 3-inch steam pipe. The throttle and auxiliary valves and the power reversing gear of the steam tender are independent of the same parts on the main locomotive and are all controlled from the cab by levers within easy reach of the engine driver. The exhaust steam is conducted by a 5-inch pipe to the rear of the tender. The reversing gear is of the Southern type, having a fixed link, which is giving general satisfaction on many lines.

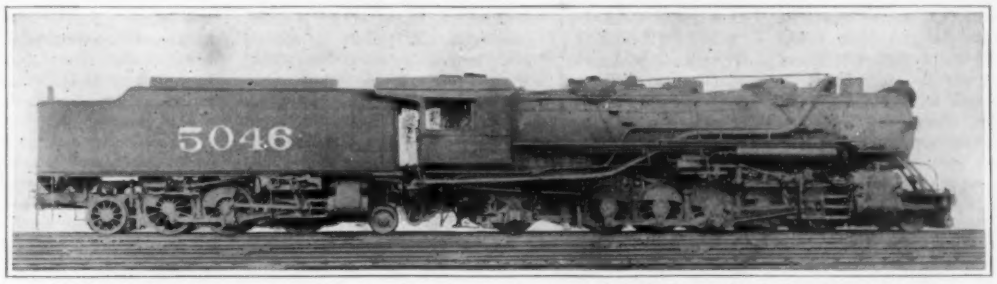
These duplex locomotives have demonstrated that the gain derived from the tractive effort of the auxiliary engine, notwithstanding the reduction of main engine boiler pressure, amounts to more than 30 per cent increase of tonnage over similar engines having the ordinary tenders.

Although it is not necessary to build new equipment to get the benefit of these improvements, advantage will be taken of the idea, and new engines will be built on the system under notice; that is to say, the tenders of standard "Mikado" locomotives will be fitted with the standard locomotive wheels and running gear for operating the tender at low speeds, thereby increasing the tonnage which can be hauled over heavy grades without the assistance of a helping engine.

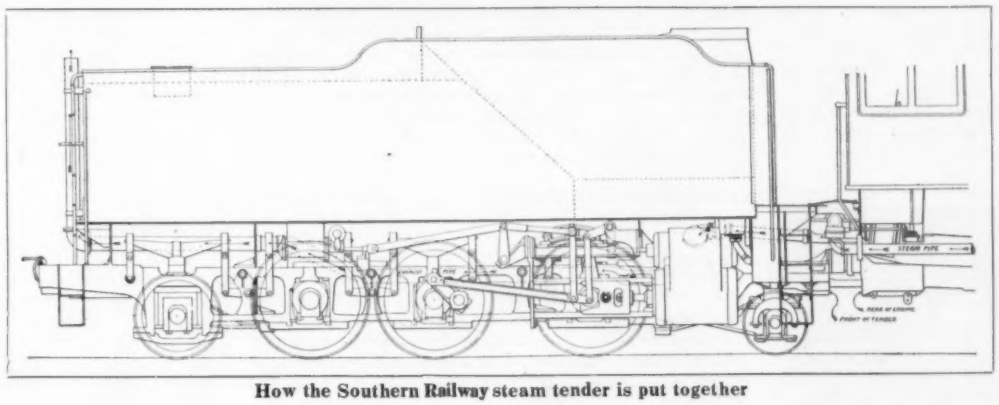
For a conservative estimate of the gain derived from the use of duplex locomotives, we will assume that a steam tender has been attached to a modern freight engine using superheated steam at a boiler pressure of 175 pounds per square inch. This engine may develop an effectual tractive effort of 51,000 pounds which may be its maximum. Should steam be taken from the boiler to such an extent that the pressure is reduced to say 155 pounds, the tractive effort of the leading engine would then be reduced to 45,000 pounds; but during this reduction of pressure on the leading engine, the auxiliary engine has been using the steam from the boiler of the front engine and developing a tractive effort of about 18,000 pounds, so that the available locomotive power for hauling the train, while decreased for lack of steam in the front engine from 51,000 pounds to 45,000 pounds, is getting the advantage of, say, 18,000 pounds tractive power from the auxiliary engine, or a net increase in draw bar pull of about 12,800 pounds and it is due to this fact that fluctuations and reductions in the steam pressure of the front engine are much more than offset by the power derived from the auxiliary engine, making it possible to increase the train haul in certain districts where the grades are favorable about 30 per cent without materially increasing the cost for fuel, as the tender engine is only used for short periods at a time and but little additional firing is required.

Of course, steam tenders are not new, but the idea of utilizing the running gear of discarded locomotives seems to have originated with the mechanical officers of the Southern Railway. Locomotives with auxiliary power have been in use for some years, notably on the Erie Railroad, and some engines on the Virginian Railway are used with success. It is also of historical interest to know that

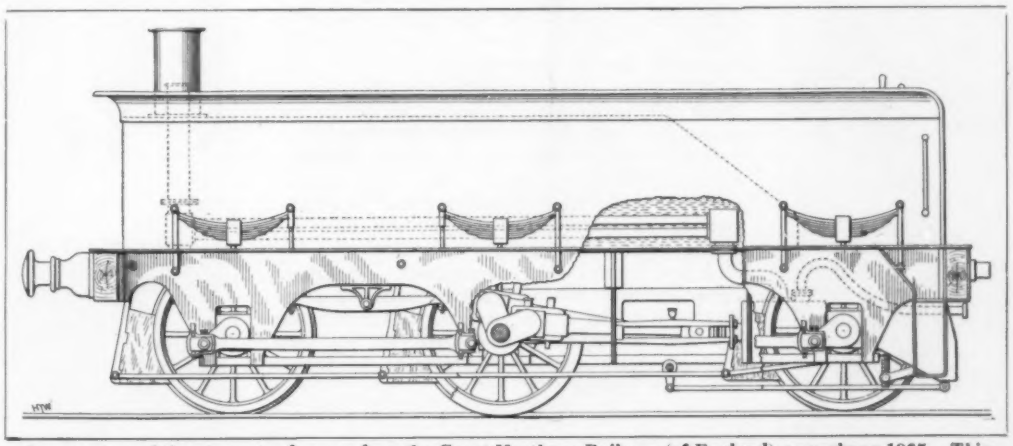
(Continued on page 630)



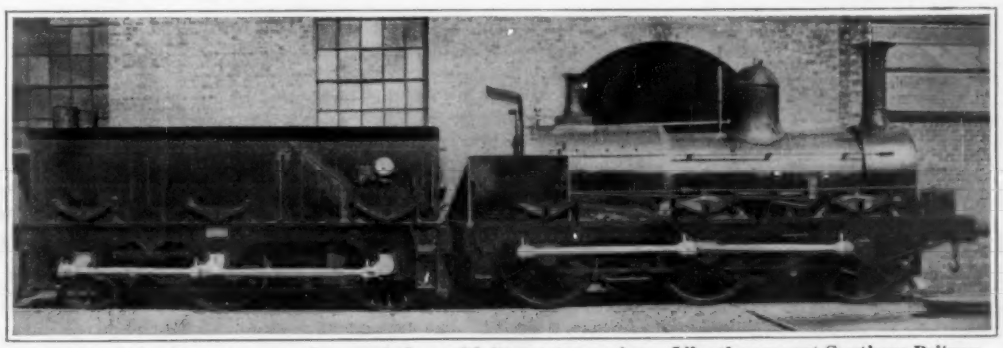
Southern Railway duplex locomotive, in which the tender is carried on the under-body of an old engine, which contributes to the motive power of the assembly



How the Southern Railway steam tender is put together



An ancestor of the steam tender, used on the Great Northern Railway (of England) as early as 1865. This steam tender was especially built rather than assembled from discarded locomotive bodies



The Great Northern steam tender coupled up with its master engine. Like the present Southern Railway model, this auxiliary power plant got its steam from the boiler of the regular locomotive, which has a producing capacity greater than the consuming ability of its own cylinders

The Romance of Invention—XIII

General George O. Squier—The Genius of "Wired Wireless"

By C. H. Claudy

IT is hardly necessary to refer here at length to the military services which General Squier has rendered his country. The statement that he has been Chief Signal Officer during the war reflects sufficient glory without the details. For it is generally conceded that of all the efficient units of our military establishment which operated abroad, the Signal Corps did the most workmanlike job. It is gratefully acknowledged by General Pershing as among those services which functioned most perfectly, and it has proved both a model and an amazement to European military authorities in the rapidity, perfection and efficiency of its work.

General Squier is first to give credit to his officers and their leadership and would be last to claim or to want to have it claimed for him that the wonderful job the Signal Corps did was done solely because of the directing brain at Washington. But it is impossible to divorce an accomplishment as a whole from the man who directed it, no matter how many assistants he had; indeed, the more capable assistants a man has the more credit to him for his ability to select and train those assistants.

However, this is not a story of General George O. Squier, K.C.M.G., D.S.M., and the Signal Corps. It is a little sketch of George O. Squier, Ph.D., Fellow of the American Institute of Electrical Engineers, Fellow of the Institute of Radio Engineers, recipient of the Elliot Cresson Medal, the John Scott Legacy Medal and the Medal of the Franklin Institute—George O. Squier, pupil of Remsen, Rowland and Newcomb, when those three most eminent men of science were contributing to the brilliancy of Johns Hopkins University.

General Squier is a graduate of West Point, and has spent his life in the service of the army. But he was born a physicist, and luckily found the lines of his army career so laid that he could make his passion run side by side with his profession. His four years at Johns Hopkins were accomplished while on military duty in Baltimore and since that time, being transferred to the Signal Corps, he has been able to indulge his love for and ability in physical science with his love for his profession, since the whole work of the Signal Corps is predicated upon establishing and maintaining communication, and communication between distant points is entirely a matter of physics.

Many of his contributions to both pure science and applied science are of such a technical nature and so little spectacular from the public standpoint, that they are little known outside of telegraph, telephone and academic circles. Others, such as the investigation into the radio properties of growing plants, and his development of trees as antennæ, and, more recently, "wired wireless," have caught the public attention from their picturesqueness. Probably "wired wireless" will be considered his greatest single contribution to both military and civilian intercommunication methods. It comes with almost a shock to learn that this idea, but just now coming into wide use, is not of today or yesterday, but was first brought out as far back as 1911, when a report on "Multiplex Telephony and Telegraphy by Means of Electric Waves Guided by Wires" was published as the first and only "Professional Paper of the Signal Corps" by the authority of Major General Leonard Wood, Chief of Staff. At that time "wired wireless" was so far ahead of the telephone and telegraph situation that, like other great inventions and discoveries which have come before the world was ready for them, it attracted little attention commercially. Moreover the wonder-working audion tube was not then developed to the point necessary to make "wired wireless" the success it is today. General (then Major) Squier's conception at the time it was put forth required expensive and elaborate apparatus, particularly in the generator. Today, the audion tube is used as the generator, with an incalculable gain in simplicity and efficiency and in the absence of complication and expense.

For the benefits of those to whom "wired wireless" is but a name, let it be said that it is a system by which the ordinary wireless waves such as are used in radio work, are guided, rather than conducted, to their appointed destination, by means of a wire. The radio waves do not run either "through" or "along" the wire in the sense that an ordinary telephone or telegraph current may run either "through or "along"; apparently they travel through the ether of space in the vicinity of the wire. The advantages so obtained are many. In the first place, true direction is obtained, the impulses going where they are led instead of being "splashed" into the etheric sea to spread in all directions. In the second place, one wire takes the place of dozens of ordinary telephone circuits, since a pair of telephone wires which normally can carry only one telephone message at a time by ordinary telephone currents, can direct a large number of "wireless" radiations of different frequencies at the same time. At present circuits are in operation in which a dozen telephone messages are going where one went before and there seems no question that this number will be extended, as our knowledge of how to bring the several different frequencies of the impulses closer and closer together extends. "Wired wireless" also makes the system to some extent independent of wire breakdowns, since a "wired wireless" wire may be broken and if its ends are not too far apart the impulses will jump the gap and continue much as if no break were present.

"Wired wireless" is an extremely flexible system. It can hook up with the ordinary telephone system and with the wireless telephone. It is perfectly conceivable that a ship at sea might talk *via* "wireless telephone" to shore, be connected *via* ordinary telephone system to the nearest distributing center, there be hooked to the "wired wireless" wire for long distance transmission and finally again connect to a city exchange, carrying the message to the individual for whom it was intended in his own home.

But perhaps to the layman the greatest marvel is not that a dozen telephone messages may be conducted by one circuit and be successfully untangled at the receiving end by a few little tubes containing heated electric wires, nor that radio telephones and ordinary telephones and "wired wireless" telephones may be connected and used together, but that "wired wireless" telephone messages may be superimposed upon ordinary telephone wires (or telegraph wires) and these wires serve as "guides" for the electric impulses passing through the ether, without in any way affecting the use of such wires for their ordinary purpose.

Just how far this truly remarkable discovery is to go in the future no one seems to know, and its parent refuses to guess. The present scribe asked General Squier for a prophecy as to the future and received a smile and reference to his report on the activities of the Signal Corps during the war as a reply. The passages referred to read:

"Advances in radio telephony and telegraphy . . . portend the day which I believe is not far distant, when we can reach the ultimate goal so that any individual anywhere on earth will be able to communicate directly by the spoken word to any other individual wherever he may be. . . . The time is not far distant, it is believed, when the President of the United States may address from the White House practically the entire American people assembled in their respective localities throughout the country to receive his message by his own voice."

General Squier is fifty-four years of age, but refuses to look it even after having run two jobs in a regular

(Continued on page 632)

General Squier in his laboratory, using a loop antenna and wireless receiving set

THERE have been many Americans who have won fame as military leaders, and many more who have achieved great distinction as men of science. But so far the catalogs of our soldiers and of our men of learning show but one name at once that of an officer of distinguished service of the first rank and a scientist of outstanding note. General George O. Squier, Chief Signal Officer of the United States Army, would be a very eminent man with his military reputation alone; he would be equally prominent in our Who's Who as a scientist alone. With his reputation in both fields, he stands in the unique position of a man who has reached the very forefront in two distinct departments of human endeavor, either of which has always been considered sufficiently difficult to take all a man's time and wit. Indeed, it would not be difficult to defend, on general grounds, the proposition that a military career demands qualities and imposes mental habits that bar all hope of scientific work of importance. Yet General Squier has shown himself to possess everything necessary in a soldier of the first rank; while what he has done in the field of science qualifies him most thoroughly for a chapter in the Romance of Invention.—THE EDITOR.

General Squier being decorated by Field Marshal Haig for his great work in the war

The Question of Natural Gas

How Our Dwindling Natural Gas Resources Are Being Wasted By an Unconcerned Public

NATURAL gas is worth twice the average manufactured gas, is becoming scarce and the demand is now greater than the available supply. Since there is no regeneration, when the gas is used, it is gone forever. When the present natural gas supplies are exhausted we must go back to the inferior manufactured gas. As there are over 2,400,000 domestic natural gas consumers, the national aspect is obvious. The situation is acute now, will become worse each year, and may be summarized as follows:

There has been a marked decline in: Rock pressure and volume of old and new wells, number of acres natural gas land held and number of producing wells per domestic consumer.

There has been a large increase in: Number of domestic consumers, domestic consumers' demands for gas service, compressing station capacity made necessary by rapidly declining rock pressure, purchase price of gas in field, compressing station operating cost, cost per million cubic feet of open flow capacity of new wells, well operating cost, and taxes.

To get all of the possible residue gas, compressing stations ought gradually to lower their intake pressures so as to get every available foot of gas out of the ground and to do this in some cases it will be desirable to operate some wells at less than atmospheric pressure.

In no case will it be prudent business or good judgment to attempt to conserve a waste of gas that would not take care of the fixed charges on the investment and the operating cost during the life of the gas that is saved, on the basis of the volume of the gas that could be obtained through such a conservation measure and delivered through the ultimate consumer's meter, at the existing market prices. An adequate price is therefore the crux of the natural gas conservation question. Unless it is made worth saving by the public, it will not be good business judgment to attempt to save it.

The amount of gas wasted is at least equal to the amount of gas used; on the basis of what it will now cost to replace natural gas with manufactured gas, the money value of the waste amounts to more than $3,000,000 each day. Domestic consumers waste more than 80 per cent of the gas received. The efficiencies of most domestic appliances can be trebled so as to make one foot of gas do the work of three. Therefore, because of the higher efficiencies that can be obtained and the smaller volume needed for the same service, increased prices per thousand cubic feet need not increase the annual cost per consumer.

Pipe Line from Havre to Paris

IT is officially announced that preliminary researches are to be carried on with a view of constructing a pipe line from the seaport of Havre to Paris, but of course it would be somewhat premature to say whether the proposed project will be actually carried out or not, although it has met with considerable favor in industrial and engineering circles. What is specially desired at the present time is to transport fuel oil to Paris to supply the needs of the city and to afford at least a partial solution of the problems which have been brought up of late by the coal crisis, as this does not seem likely to come to an end in the immediate future. The fuel oil question is occupying considerable interest just at present, and as it will not be a difficult matter to bring it into France by tank steamers, the use of a pipe line would of course be an important factor in the question. Conditions prevailing in America and in Russia for pipe line construction are now being examined by French engineers, and in view of the great lengths of line now in use in America, and the Russian lines, especially the 550-mile pipe line between Baku and Batum, there seems no difficulty whatever in laying the proposed line from Havre to Paris. But the question is principally of an economical nature, and some objectors to the scheme say that it is a different matter to run a pipe line from a point of production to an exporting seaport, such as is done elsewhere, and to transport oil in this manner (as in France) from an importing seaport whose intake must necessarily be of limited nature, to an isolated consuming center such as is the case here. Proper calculation of cost will be needed in order to show whether it would not be preferable to devote the time, money and labor to improving the existing facilities, and especially the tank car transportation. The problem is thus clearly set forth, and it remains to determine which solution will be the most advantageous.

Glycerine from Fermented Molasses and Sugar

MANY attempts have been made to extract glycerine from solutions containing one or another kind of sugar, but it was not until 1917 that a successful practical process was achieved in Germany. The highest yield of glycerine was obtained from solutions containing 19 to 20 per cent of sugar and 5 per cent of sodium carbonate, the latter being added progressively as soon as the fermentation is well begun. The best temperature is from 30 to 32 degrees Centigrade, a higher temperature causing losses both of alcohol and of glycerine, while at a lower temperature the yield is diminished. When the fermentation is properly conducted from 20 to 25 per cent of the sugar employed is transformed into glycerine.

In Porto Rico this process is employed in the treatment of the non-edible molasses called "black leather." The total fermentation requires five days and at the end of this time analysis shows a yield of 3.1 per cent of glycerine, 6.75 per cent of alcohol, and 0.86 per cent of sugar; 3.6 grams of sodium carbonate per 100 cubic centimeter are required to produce the proper degree of alkalinity. The fermented juice is purified by first neutralizing by means of sulfuric acid and then adding a saturated solution of ferrous sulfate. It is then brought to the boiling point after the addition of milk of lime. After the addition of the sodium carbonate it is concentrated in a vacuum pan. About 50 per cent of the glycerine actually contained in the juice is finally extracted in a Jobbin apparatus. This glycerine is then ready to be nitrified.

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

A Question of Credit

To the Editor of the SCIENTIFIC AMERICAN:

In her able review in the SCIENTIFIC AMERICAN magazine of the article on human grafting by Dr. Serge Voronoff in *La Revue* (Paris), Mae Tevis gives the impression that Voronoff takes full credit to himself for the operations he describes, and accords none at all to the American surgeons who invented them and from whose writings he probably learned them.

I have not seen Voronoff's article, but think it highly likely that he gives no such credit, for when he exploited his grafting of the interstitial tissue of the glands of reproduction he failed entirely to mention that this very operation had been described fully by Dr. G. Frank Lydston of Chicago six years ago.

It may be possible that the operations mentioned in this latest article are new to European surgeons, though even this is not probable; but they have been performed by American surgeons for many years. As one reads of Voronoff's work in bone-grafting, the names of Albee and Murphy recur at once to the mind, and Voronoff needed nothing but a file of "The Clinics of John B. Murphy" to learn the technique of all his vaunted operations. As for the work with glands, Hammond and Sutton did it here in America in 1912, and Dr. Lydston's series of articles in the *New York Medical Journal* for October and November, 1914, contains no less than forty-seven references to already published works on gland-grafting, most of them by American surgeons.

Voronoff displays a peculiarly German trait in appropriating the discoveries of Americans and exploiting them as his own, trying to convey the impression that he is a pioneer, while really he is only following trails long since blazed by others.

ARTHUR BENINGTON.

New York, April 20.

Some Gravitational Reflections

To the Editor of the SCIENTIFIC AMERICAN:

I would like to call attention to a few points that seem to cause a great deal of confusion in discussing the problem of gravity. The thing that causes the most confusion, is the statement, often made, that a body can't act—attract or repel—where it isn't. The foundation for many false conclusions lays in this statement. The statement gives one much the same sense of inconceivableness, as another statement very much like it, a body can't be where it isn't. The proposition isn't put properly. A body certainly can't act where it isn't, but it can act where it is, which is not so inconceivable a proposition.

If we can't think of a body attracting another a million miles away, we can't think of it attracting another one mile away, if not one mile not one inch, if not one inch not 1/1,000,000 of an inch, if not 1/1,000,000 of an inch, not in actual contact; if not in actual contact, not under any condition whatever. Not even by an intervening medium, because the parts of the medium would be held together by cohesion.

Reverse the reasoning; if we can think of attraction at all, under any condition, such as in actual contact, we can think of it acting at any distance, without any medium. The thinkableness or unthinkableness depends on the kind of start you get.

Action at a distance—attraction and repulsion—is not unthinkable at all. It is not unthinkable like a thing being where it isn't, which is truly unthinkable. We can't say that things we see and hear and feel are unthinkable. If they were we couldn't say anything was thinkable.

The same reasoning applies to resistance at a distance or repulsion. If we can't think of resistance at a long distance we can't think of it at the smallest possible distance; we couldn't even think of matter resisting in contact. If attraction and repulsion exist at all we can think of them as acting at a distance. The fact that matter resists being pulled apart or compressed is positive proof that attraction and repulsion exist.

Why not accept action at a distance without intervening medium as a scientific fact?

WM. CROCKER.

Prescott, Ariz.

Spirit of the Times

To the Editor of the SCIENTIFIC AMERICAN:

Your editorial of April 10, under the above title suggests the question: What is the essential difference between Emerson's idea of : "An immense intelligence which makes us organs of its activities and receivers of its truth" and your idea of reaction to those agencies with which we are well acquainted? In both cases it is understood that structure, of which intelligence and accumulated knowledge is one essential element, reacts to forces of a peculiar nature. Many think, as does Dr. Conant—see page 389—that there are life or vital forces with which we are unacquainted. We know there are activities peculiar to life, like reproduction, growth, metabolism and adaptation to environment, which are synthetic in their systematic action. It is generally agreed there are forces like calories and vitamines in food, ideas and sentiments for the intellect and what is spoken of as spirit or personality observed in associating with others. Would you say there is no living energy that can be distinguished from mechanical energy, in the same manner we distinguish between elementary, compound and organic substances? In other words, that there is no analogy between substance and energy. Is man as a physical being the highest type of life of which we can form any conception?

There seems to be less difference in men's perception of truth than in their modes of expression and the mind pictures they form. It is much like the confusion of tongues spoken of when men attempted to build a tower unto heaven. It is observed that when for a moment they forget theory and doctrine all are inclined to express themselves in a similar manner.

By the way, what one word, English or foreign, can be used to express the idea, "Spirit of the Times"? It is a common idea, which, I am under the impression, has been given a name. H. BETTES.

Cuyahoga Falls, Ohio.

[The German word Zeitgeist is perhaps the one Mr. Bettes has in mind; we know no other that fills his order. Of course, if English possessed the same trick of stringing several words together and calling the result a word, we should be able to meet his requirements in our own language, with a combination quite analogous to the one we offer above.—THE EDITOR.]

Challenger and Defenders of the America's Cup

Leading Characteristics of "Shamrock IV," "Resolute" and "Vanitie"

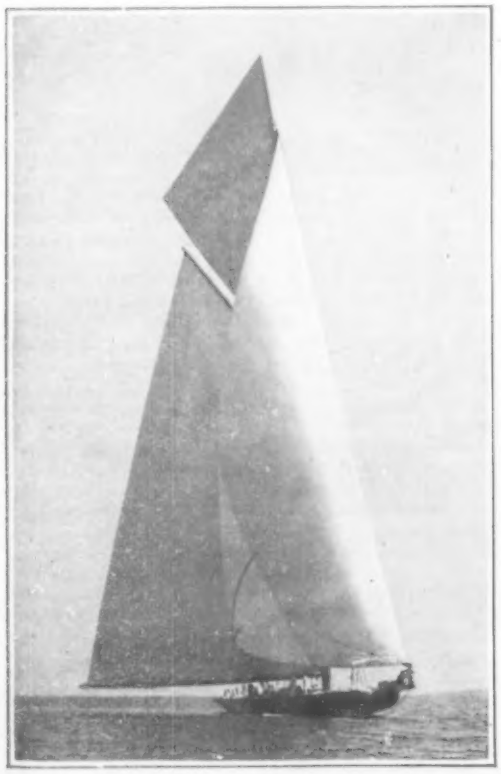
By J. Bernard Walker

BY the courtesy of Mr. C. E. Nicholson, designer of Sir Thomas Lipton's challenging yacht, "Shamrock IV," we are enabled to present the exact outboard profile, midship section, and other leading characteristics of the British craft. Similar data regarding the cup defenders, "Vanitie" and "Resolute" were published in our issue of May 2, 1914, when we little dreamed that a furious contest between ships of war was to take the place of the proposed friendly struggle between ships of pleasure.

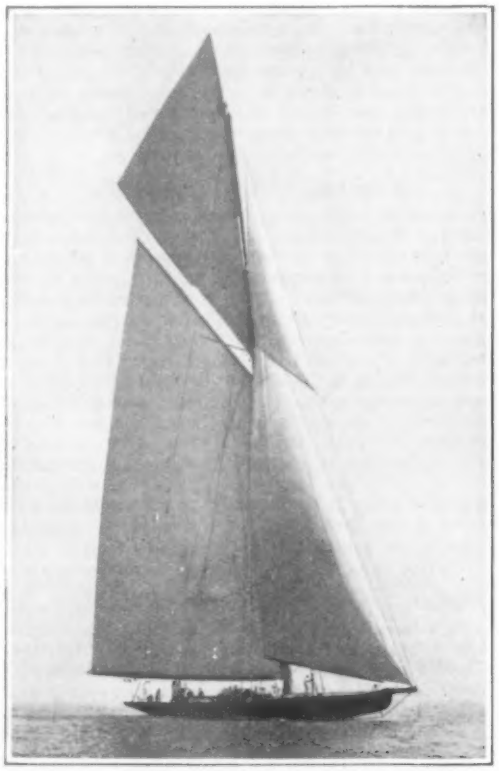
With regard to the diagrams of the three yachts, we invite attention to the curious fact noticeable in a comparison of "Resolute" with "Shamrock IV," that the American and British designers have changed places during the past thirty years. For if we go back to the sloop-versus-cutter era, say of the Thistle-Volunteer contest, we find that the British cutter was a boat of moderate beam and a deep V-section, with easy bilges, large displacement and moderate sail area, whereas the sloop derived her greater sail-carrying power from her great beam, and hard, full bilges. Comparing the midship section of "Resolute" and "Shamrock IV," it will be seen at a glance that it is now the American boat that has the easy bilges and is full at the garboards, and that it is the English boat that has the greater beam, the hard bilges, the long, flat dead rise and the sharp turn at the garboards; while as regards sail area, the difference is enormous in favor of the British boat, seeing that she has almost exactly a 25 per cent greater sailspread.

"Resolute" comes from the designing board of Nat Herreshoff; the other defender, "Vanitie," was designed by William Gardner, who has always run Herreshoff rather closely for first honors in racing yachts of the various classes. "Vanitie," which was built in 1914 for Alexander S. Cochrane, has been deeded by him to the New York Yacht Club, and both "Vanitie" and "Resolute" are now having their competitive trials under the management of that club, with a view to selecting the better boat for meeting "Shamrock IV" in the races of 1920. Referring to our comparison above of "Shamrock IV" and "Reliance," it can be said that "Vanitie" comes midway between these extreme types.

The three yachts were designed in 1914 under the new rule of measurement which was intended to correct the defects of the old rule. Under the old rule, waterline length and sail area only were considered. So long as the yacht did not exceed 90 feet on the



On a broad reach, carrying balloon jib and largest clubtopsail



Shamrock IV, whose spread of sail reaches 170 feet above the deck

water line, the designer was free to make her as broad, as deep, and as long on deck as he pleased, and he could give her as large a sail plan as he wished. Working under this rule, it was found that a yacht with a broad, shallow, scow-shaped hull, with long overhangs, carrying a great mass of lead at the bottom of a deep keel, and driven by a vast spread of sail, produced the fastest yacht under the average weather conditions off Sandy Hook. The most extreme yacht built under that rule was "Reliance," which, with 90 feet of waterline length, measured 140 feet on deck and spread over 16,000 square feet of canvas.

Now, the old rule produced "freak" yachts. Their spars were too big, their hulls too shallow and their draft too great, to render them useful as cruisers; the races over, they were generally broken up for junk.

The new rule was drafted with a view to producing a more wholesome boat, with a larger displacement, a smaller draft, and a sweeter form with sharp ends—that is to say, a form which would have a much easier motion in a seaway than the old scow form, whose full, flat bows pounded heavily and made the boats extremely wet when thrashing to windward in a short sea.

Now in drafting out a racing yacht of the kind that competes for the America's Cup, the designer may approach the problem from two different angles. He may decide to build as small a boat as he thinks will have sufficient speed, plus its time allowance, to make sure of winning the cup; or he may decide to build the largest and most powerful craft that can be brought within the limits of length, draft and displacement laid down, believing that the higher speed gained from size and power will more than offset the time allowance which he must give to the smaller craft. What makes the contest this year so interesting is that whereas, let us say, Herreshoff has built a boat of moderate form and power, Nicholson has gone to the very limit in the other direction and turned out a boat in which he has bid for power in every direction in which it could be secured. If "Vanitie" should be chosen to defend the cup, "Shamrock IV" will undoubtedly have to give considerable time allowance to that boat, and should "Resolute" be chosen she will have to yield so large a time allowance that unless she shall show phenomenal speed on all points of sailing, her task would seem, at the very first sight, at least, to be something of a forlorn hope.

The hulls of the American boats are built of nickel-steel framing, plated with manganese bronze. The "Resolute" construction consists of a series of 16 web frames, 8 to 12 inches in depth, with lighter frames between, the latter extending from keel to bilge, and longitudinal framing following the seams of the shell plating, which is 5/32-inch manganese bronze. She is decked with aluminum plates 7/32 of an inch thick, the whole being covered with canvas, sanded to give a good footing.

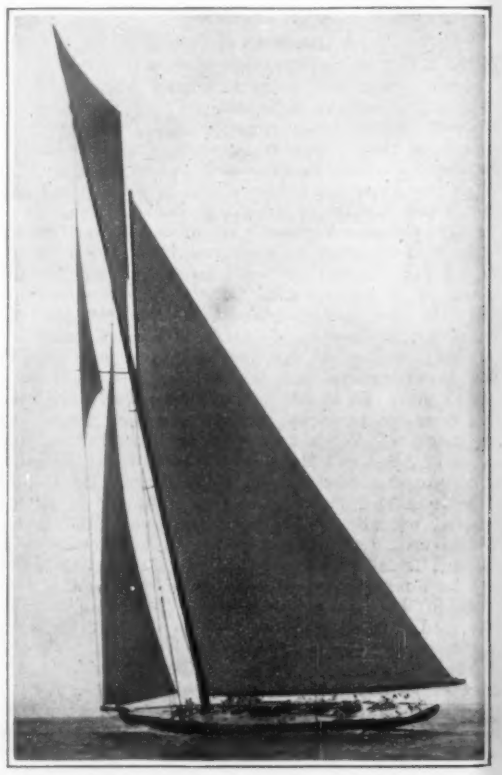
"Vanitie's" framing consists of eight 10-inch web frames, with light intermediate frames extending from the keel to the deck. As originally built in 1914, she had a light pine deck laid on nickel-steel deck beams. In both yachts the masts, 20 inches in diameter, were built of nickel-steel, with angle-iron stiffeners.

A study of the plans which we publish shows that, upon every point of comparison, the hulls of the challenger and the defenders are as wide apart, both in design and construction, as they can well be. Herreshoff, seeking to take every possible advantage of the new rule and secure as small a rating as possible, has built a small boat of moderate power; whereas Nicholson has been willing to incur heavy penalties in order to secure a boat of great initial stability, capable of carrying a huge spread of canvas. The result is shown in the fact that, though the boats are of practically the same displacement, 105½ tons for "Resolute" and 106 tons for "Shamrock IV," the latter carries 25 per cent more canvas, or 10,800 square feet as against 8,650 square feet for "Resolute."

The explanation of this anomaly is to be found in the form of the hulls, the character of their construction, and the placing of the lead ballast; and it is in the daring with which he has handled these problems that designer Nicholson has produced a challenger, which, for startling originality, may well make the yachting sharp gasp at the first sight of her.

In the matter of form, or model, he has adopted the champagne-glass midship section, which characterized "Reliance" and "Independence," with full, hard bilges which, in defiance of the quarter-beam penalty imposed by the new rule, he has carried out well into the bow and stern sections.

In the matter of ballast he has lengthened his lead to 32½ feet and bulbed it out to a width of 3½ feet with the result that its center of gravity is only about



Close hauled on starboard tack. Note the perfectly fitting canvas

16 inches above the bottom the keel. The lead on "Resolute" being only 20 feet long, necessarily extends much higher, and its center of gravity, since it is not flared out at the base, is about 30 inches above the base of the keel—a difference in the righting moment of the lead which means more sail-carrying capacity for the same weight. This long, low lead means a very large lateral plane—good for windward work but bad for progress in light airs, when the large wetted surface involved will prove a handicap.

But it is in the construction of the hull that the greatest departure has been made. The framing consists as in the American boats of deep web frames, widely spaced, with light angle-iron frames between them, but this framing is of such lightness that, when one thinks of the towering rig aloft reaching 170 feet above the deck, and the 67 tons of lead below, it is puzzling how the hull can carry the heavy stresses to which it is subjected. But if you ask designer Nicholson he will tell you of the wonderful strength of carefully selected, well-seasoned and properly disposed wood. He will explain that the hull is sheathed with three layers of mahogany, two layers, ½ inch thick, placed diagonally in opposite directions at 40 degrees to the vertical, and an outer layer ⅝ inch thick, placed longitudinally, the whole being very thoroughly fastened together, with the joints evenly distributed.

Although "Shamrock" is nearly seven years old and was sailed hard across the Atlantic, and has never been caulked, she is tight as a drum today. In the designer's eyes, the value of this construction lies in its continuity. It is practically without joint or seam, and to great strength and toughness it adds what merit there may be in its elasticity.

The deck is of birch veneer, ⅝ of an inch in thickness, and the hull is stiffened against distortion by running birch veneer bulkheads at each web frame from the bilge to the deck along each side of the hull. The hull is also stiffened longitudinally by a series of wood longitudinals, about 2½ inches square in section. The fact that "Shamrock" carries more lead and a much heavier rig on a larger hull, for the same displacement, shows how extremely light the construction of the hull must be.

Another striking novelty (for a cup yacht) is the tumble-home of the topsides, which will assist to give the boat long, easy sailing lines, when she is rail down in a stiff breeze. She will not tend to "roll out," as a boat with flaring topsides is apt to do, and with her huge sailspread she should, like "Independence," gather speed quickly when sheets are eased on a reach.

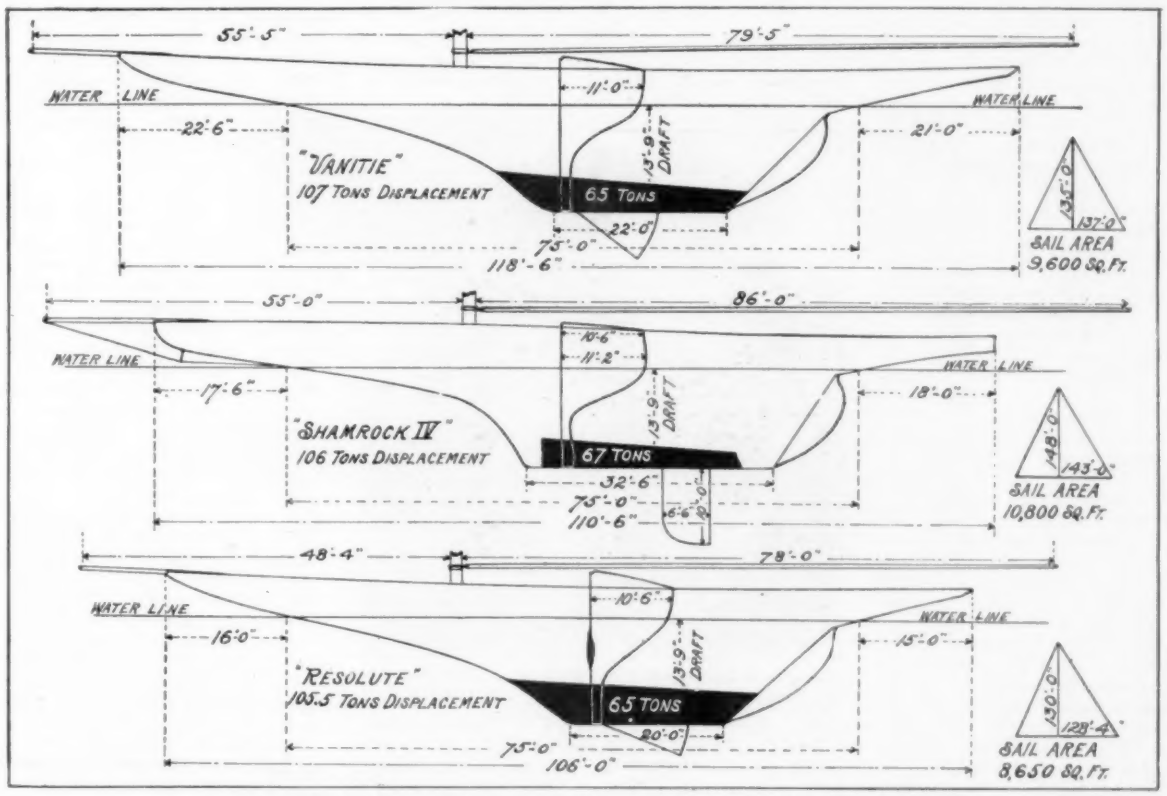
The great height of the rig, coupled with the tumble home, necessitated the use of outrigger chainplates—another return to abandoned practice. The mast, 2 feet in diameter, is of wood and hollow, as are the other spars. The topmast truck is 145 feet and the top of the clubtopsail 170 feet above the deck. This means that if the "Shamrock" were afloat on Broadway, the topmost point of her clubtopsail would be level with the cornice of a 14-story building—and this, remember, on a waterline of 75 feet.

All the yachts have made changes over 1914 in preparation for the 1920 races. "Shamrock" has the same rig, but she has lightened herself by cutting off 8 tons of lead from the ends of her keel and bolting a 5-ton pad along the bottom. To bring her down to the 75-foot length a mahogany pad several inches in thickness has been worked on to her stem.

The changes in "Vanitie" and "Resolute" have been in the direction of larger sail area; and the former has paid the visitor the compliment of adopting the veneer deck, while "Resolute" has followed suit by changing from a steel to a hollow wooden mast.

	Shamrock IV	Vanitie	Resolute
W. L. Length	75′	75′	75′
Draft	13′9″	13′9″	13′9″
Beam	22′4″	22′	21′
Overhang forward	17′6″	22′6″	16′
Overhang aft	18′	21′	15′
Length over all	110′6″	118′6″	106′
Fore triangle base	55′	55′5″	48′4″
Boom	86′	79′5″	78′
Deck to topmast	148′	135′	130′
Lead, tons	67	65	65
Displacement, tons	106	107	105½
Sail area	10,800′	9,600′	8,650′

There has been much comment about the appearance of a slight "hogging" in the deckline of "Shamrock." The freeboard is 6′2″ at the stem. The deck runs straight to a point above the forward end of the waterline where the freeboard is still 6′2″—this to prevent water from coming aboard and keep the chainplate outriggers clear of the water. From this point the deck falls to a freeboard of 4′7″at the after end of the waterline. Then it rises one inch to 4′8″ at the stern.



Midship sections and outboard profiles of "Vanitie" "Shamrock IV," and "Resolute"

As to the coming races, "Shamrock" is certainly a dark horse, and until the starting gun is fired off Sandy Hook, no one, not even the designers themselves, can guess whether challenger or defender will open out a lead. We know that "Resolute" and "Vanitie" have sailed a 30-mile course faster than it has ever been sailed in these waters; we know also that "Shamrock IV" has beaten "Shamrock III" (the fastest 75-foot yacht in British waters) a minute and a quarter a mile on a 15-mile beat to windward. The result would seem to turn on the question whether she can save the five, six or seven minutes of time allowance which she will have to allow the American boat.

A New Kind of Bacteria

RECENT investigations are showing more and more the extent to which bacteria are potent in another field than disease.

Geologists are realizing more fully as they extend their studies the magnitude of the work done by plants and animals in building up and tearing down parts of the crust of the earth. Even microscopic organisms perform a large part of this work. Pasteur long ago showed not only the deadly power of bacteria in disease and their efficiency in promoting fermentation, but also their influence on the fertility of soils and their work in expediting rock decay are still subjects of scientific study. Bacteria evidently not only aid in the decomposition of rocks and in the formation of beds of chalk and limestone, as has recently been demonstrated, but are active agents in the deposition of some beds of iron ore. Engineers have learned that iron-depositing bacteria may be troublesome pests through their ability to clog the pipes of city water-supply systems with hard, thick crusts and slimy, rusty masses composed of millions of individuals. Mr. E. C. Harder, of the United States Geological Survey, who has examined deposits of iron ore in many countries for the special purposes of determining their mode of origin, has recently made close studies of the action of bacteria in forming iron ores. He has found the so-called "iron bacteria" actively engaged in the deposition of compounds of iron, not only in the surface iron-bearing waters, but in mine waters to depths of several hundred feet, and has made laboratory cultures of various iron-depositing bacteria.

X-Ray Paper

DR. G. W. K. CROSLAND and Mr. T. P. K. Crosland, of Huddersfield, are the inventors of a novel and ingenious device relating to X-ray photographs and radiograms, which has for its object the provision of a sensitized flexible material or paper so prepared as to admit of one, two or more copies being directly obtained with one exposure and avoiding the loss of time occupied in making an exposure on glass and then printing from same, such flexible sensitized material being advantageous in that it is easily adapted to any part or angle or curve being radiographed, while there is no risk of breakage. The inventors take a sheet of paper or like flexible material previously sensitized in any known manner and treat or coat the same with a paint or wash of venetian red, chrome yellow or other suitable preparation which is impervious to light and is easily removable by washing or other similar process. The said opaque coating or covering forms an adequate protection to the sensitized surface and admits of the paper or material thus treated being handled or carried openly, and dispensing with the use of light-tight envelopes, cassettes and the like, the treated paper being made up in single sheets or arranged in books, packets or blocks containing the desired number of sheets.

For producing a print or prints, the prepared sheet or material or two or more superimposed sheets or papers is supported behind the object to be radiographed and may be placed in any angle to best suit the object, or in any curved surface to bring the whole of the surface as near to the object as is possible to give the best results, the print being thus taken directly on the paper or sheet or a like print on each of the superimposed papers or sheets which are subsequently washed or treated to remove the opaque surface by coating and develop the print or prints.

By means of this invention, X-ray photographs or radiograms can be produced with the utmost rapidity whereby immediate inspection of the finished print is obtainable, this in many cases being of considerable value. The cost of manufacture of the sensitized paper being less than that of sensitized glass and the subsequent developing operation being minimized, the production of radiograms is cheapened.—By *A. H. J. Keane.*

Putting Plants on Daylight Rations

How Production May Be Artificially Hastened by the Proper Control of Light Exposure

FOR generations scientists have known that sunlight was necessary for normal growth of most kinds of plants, and, although the summer sun might occasionally become too hot, they have understood that it could not cause any injury except perhaps the injury due to burning. A recent discovery by W. W. Garner and H. A. Allard of the Bureau of Plant Industry, United States Department of Agriculture, shows that, entirely apart from any effect of burning, it is possible for plants to have too much daylight or, in other words, too many hours of daylight in comparison with the number of hours of darkness. Too long a day as well as too short a day will prevent many kinds of plants from ever reaching their stage of flowering and fruiting.

Furthermore, the intensity of the light has very much less significance upon the growth of the plant than has usually been supposed. Greenhouse experiments prove that the flowering and fruiting period of practically any plant can be made to take place at any time of the year by darkening the greenhouse in the morning and evening if the day is too long, or by lengthening the day by artificial light if the day is too short. This new theory of controlling flowering and fruiting of plants undoubtedly will be used by florists and other greenhouse operators. For example, violets bloom only during the comparatively short days of spring; but if violet plants are covered with light-proof boxes at night and not uncovered until the sun is about half an hour high each morning during the summer time, violets can be forced to bloom in the summer. Spring flowers and spring crops happen to be spring flowers and spring crops because the days at the season of their flowering and fruiting have the proper number of hours of daylight. Correspondingly, the early summer flowers and crops must have a longer period of daylight. This has been proved as to a large number of plants, and the scientists believe that the principle will hold throughout the higher forms of plant life, and that it is probably applicable to animal life as well.

The plant cannot attain sexual reproduction, it has been shown, except when it is exposed to a favorable length of day. The requirements, however, differ widely with species and varieties. But a length of day that is unfavorable to reproduction may be favorable to growth. Under that condition, the plant continues its vegetative development profusely and indefinitely without bearing fruit. A length of day may be found that is favorable both to sexual reproduction and vegetative growth. That tends to bring about the "ever-bearing" type of fruiting.

By employing dark chambers to shorten the period of light and artificial lights to extend it, scientists of the Department have shortened or lengthened the life cycle of plants, have made some of them complete two cycles in a single season, have brought others into flower and fruit months in advance of their regular time, and, with still others, have greatly delayed and even completely prevented fruiting.

Long series of tests have been made with soy beans,

Dark box used by the U. S. Department of Agriculture for controlling the light exposure of plants

tobacco, wild aster, climbing hempweed, beans, ragweed, radish, carrot, lettuce, hibiscus, cabbage, violets, goldenrod, spinach, cosmos, iris, beggartick, buckwheat, and various other plants.

Ragweed developed in the dark box. The plants at left have had too much daylight, as compared with those at right

A test made with Biloxi soy beans will show how the principle works. For the test plants the day was shortened by several hours. That is, they were exposed to the light only from 10 o'clock in the morning till 3 o'clock in the afternoon. They were first placed in the dark house on May 20. Control plants, otherwise treated exactly like the test plants, were left exposed to the light from dawn till dark. The first blossoms appeared on the dark-house plants on June 16. No blossoms appeared until September 4 on the plants that were left in the light all day. But the dark-house plants averaged only 6 or 7 inches high while the plants that were left in the light all day grew to an average height of 57 or 58 inches.

These plants required a short day and a long night for flowering and seed bearing. In tests with other plants, just the opposite was found to be true. The plants that were left in the light all day did not grow luxuriantly, but produced flowers and seed, while those that were kept in the dark a part of the day made abundant growth, but produced no seed or else were greatly retarded in producing seed.

Temperature appeared to exert no influence in these tests. The results were the same, even when the temperature was higher in the dark house than on the outside. Another striking illustration of the relative unimportance of temperature is the fact that plants kept in the dark for a part of the day underwent, in midsummer, the changes that in nature come in the fall and have always been attributed to lower temperatures. This, also was true even when the dark houses registered a higher temperature than that of the outside summer atmosphere.

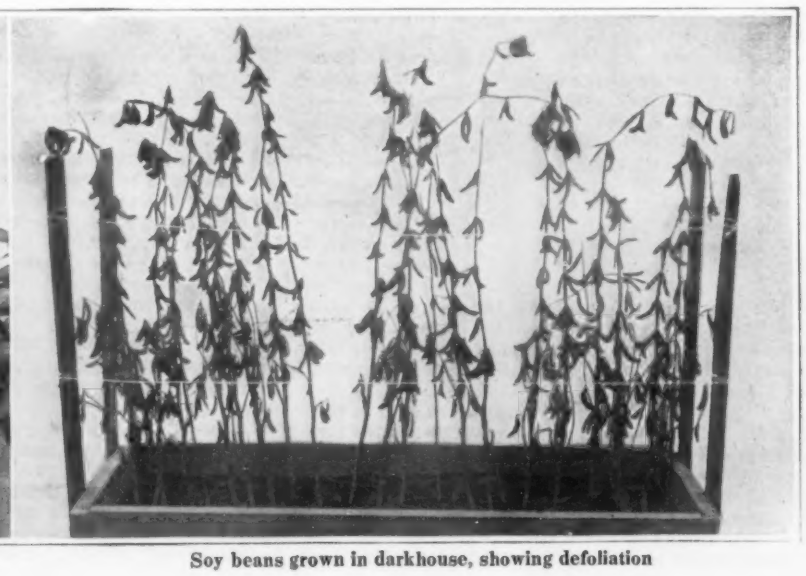
The results obtained by artificially extending the period of light are just as interesting as those obtained by artificially shortening it. The artificial illumination, in a test with iris, was so arranged as to give 18 hours of continuous light in a greenhouse during the winter. Control plants were kept in a similar greenhouse with no artificial light. The test was begun on October 20, 1919. In the greenhouse where daylight was supplemented with electric light the plants made rapid growth, soon attained normal size and produced blossoms on December 24. The plants in the greenhouse where no artificial light was used, though it was kept at the same temperature, remained practically dormant and showed no tendency to blossom as late as February 12, 1920.

The influence of this discovery on crop yields is likely to be of no little importance. The length of day is proved to be the most potent factor in determining the relative proportions between the vegetative and fruiting parts of many crop plants. Indeed, fruiting may be completely suppressed by a day either too long or too short. The advance in agricultural practice which may come through this new discovery will have to be brought about largely by plant breeders and other crop specialists. For instance, it will prove of material significance in the future planning of cropping systems for different regions, especially where consideration of new crops from different latitudes is necessary.

This new principle undoubtedly explains the erratic behavior which has been observed with many crops

(Continued on page 634)

Soy beans kept out-of-doors, showing no defoliation



Soy beans grown in darkhouse, showing defoliation

Evolution in plant hauling: The electric tractor now being used by a large packing plant, gasoline tractor removing snow after blizzard, and former electric trolley system now displaced

Why the Industrial Tractor and Trailer System Makes Good

WHAT is perhaps the oldest electrified elevated railroad in the world is going out of business. One of the picturesque sights of the Chicago Stock Yards, this railroad has been on the job for the past 28 years, hauling meat and other packing house products between various departments of a great Chicago packing house plant. This system has done its work well, too, but a better method has been found and in the interest of greater efficiency the elevated trolley system, operating on narrow gage tracks, will soon give way to a fleet of electric tractors hauling trailers which are not hampered by tracks but have the ability to travel anywhere.

Away back in 1892 the elevated trolley system was installed to haul the products of the packing plant to the loading platform and the various other departments. This was the same year that the first passenger trolley car appeared on the streets of Chicago. The latter was a surface line for passengers, while the packing plant system was an elevated line for freight. The following year an elevated railway line for passengers made its appearance in Chicago, the cars being drawn by small steam locomotives.

An elevated transportation system was virtually forced upon the packing plant, by the congestion of freight, which was a regular thing even in such early days of the industry as 1892, before meat packing activities had reached anything like their present proportions. To relieve this congestion in the streets about the plant, an elevated street was built, and the overhead trolley car system of transportation was installed at a cost of about $75,000. This elevated road connected all manufacturing departments to each other and to the main shipping points. The equipment consisted of seven trolley cars, containing 15-horse-power, 500-volt motors; 950 trailers of various designs; three miles of overhead trolley and the same length of narrow gage track.

For years the overhead trolley system proved adequate for the needs of the great packing plant, but gradually the business of the company expanded, which meant more territory for the trolleys to cover, and considerably greater tonnage each year to handle. By 1917 the Chicago plant of the packing company covered 39 acres, and the result was a great number of long hauls between the point where the products were manufactured and the common assembly or shipping point. Figures for that year showed that the amount of goods handled by both its elevated road and hand trucking totalled approximately 405,000 tons.

By 1917 the requirements of the packing plant had outgrown the facilities of the inter-departmental traffic system. Furthermore, the plant experts found, on investigation, that there was a great deal of unnecessary hand trucking done about the plant, which they felt should and could be eliminated. Because of these developments, the first tractors were installed at the plant, and worked on test along with the elevated trolley system. It was soon discovered that they had certain advantages which the trolley system did not possess. They could go anywhere—they were not restricted to tracks. They could carry goods from the source to the destination. Thus the number of handlings was greatly cut down. And so the fleet of tractors grew in size. Today there are sixty.

Before testing the tractor and trailer system against the trolley car system of transportation, tests were made and the cost kept on the tractor system *vs.* the hand-trucking system. From the assembly room to

(Continued on page 634)

An electric motor geared to the capstan enables the man to haul one or more cars on a siding

Getting Along Without the Switching Locomotive

WHY use a switching locomotive, with its crew of two, every time a car or two must be shifted along the siding of the industrial plant? The answer is that a switching locomotive is not necessary, thanks to an electric capstan recently introduced for just such a purpose.

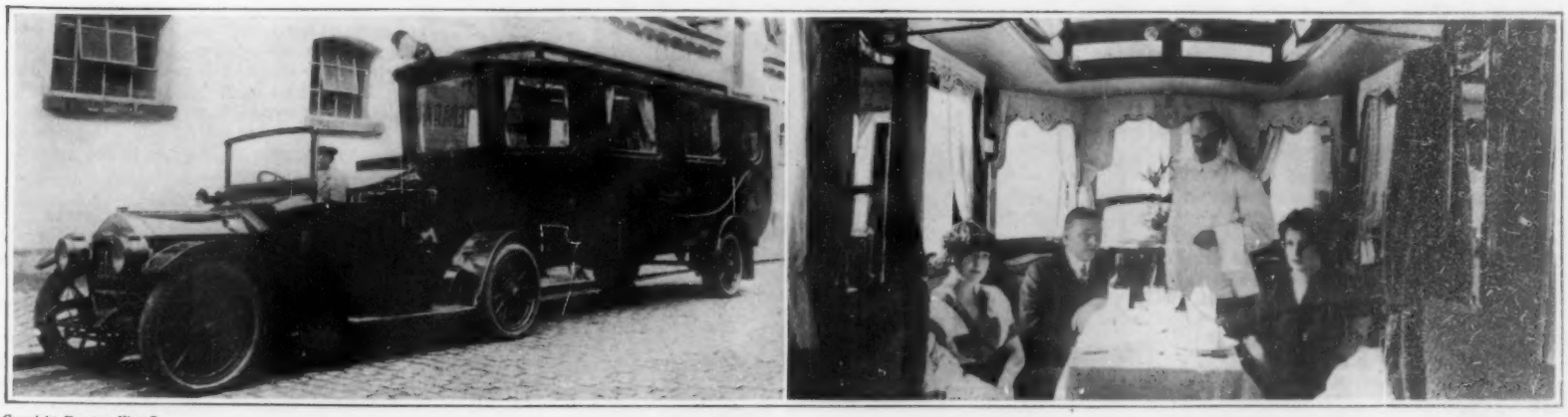
The car puller, as this device is called, consists of a powerful electric motor driving a capstan through a low reduction gear. In order to pull one or two cars along the track, one end of a stout rope is made fast to a car while the other end is wrapped around the capstan and pulled by the operator so as to ensure a firm hold. A handle protruding through the motor casing serves to start and stop the motor. The accompanying illustration, as well as our front cover, serves to convey an accurate idea of the operation of the electric car puller.

Visiting Europe's Battlefields via Automobile Pullmans

IN anticipation of the rush of tourists to the battlefields and devastated regions of France and Belgium, enterprising persons and companies in those countries have been making elaborate preparations for some time past. Some of these take the form of comfortable if somewhat plain hotels and restaurants; others the form of special buses for touring the scenes of former conflict; still others the form of airplane touring services, and still others in the shape of road pullmans, so to speak.

The accompanying illustrations depict one of these so-called road pullmans or automobile pullmans, now available to tourists. This vehicle, it will be noted, consists of a heavy and powerful automobile hauling a luxuriously-fitted trailer. During the day time the road pullman carries twelve passengers with ease, and during the night accommodations for six can be comfortably provided. The panels of the car are so constructed as to form hanging cupboards and shelves, while the after part of the car contains an electric kitchen and buffet.

This method of visiting the war zone makes the tourist independent of hotels and restaurants. Furthermore, the trailer can be left standing at any place desired, while the automobile proceeds to the nearest village for provisions.



Copyright, Keystone View Co.

This road pullman is now available to tourists visiting the devasted regions and erstwhile battlefields of France and Belgium

1. Harvesting the cacao fruit from low-growing trees by means of the pruning knife. 2. Cacao seedlings in wooden pots for transplanting without disturbing seeds and earth. By the time the roots are ready to grow beyond the limits of the pot, the latter has rotted away. 3. The cacao bean as it grows in Mexico.

Scenes from the home of the cacao tree, showing how the bean is cultivated and what it looks like

Where Chocolate Comes From

How the Cacao Bean is Grown and Made into Cocoa Powder and Chocolate

By W. A. Murrill, Ph.D., New York Botanical Gardens

SUGAR gradually found its way into the New World from India, while one of the first American products to be carried back to Europe and Asia was the cocoa bean, from which cocoa and chocolate are manufactured. Montezuma, the famous Aztec king, drank chocolate from a golden cup and had in reserve fifty jars or pitchers of this delicious beverage for his own personal daily consumption, with considerably more for his household.

In preparing this chocolate, the beans were roasted, crushed on a flat stone, flavored with spices, and boiled for some time in water, the liquid meanwhile being beaten into a foam. The Mexican name "chocolatl," or "cacahuatl," was abbreviated by the Spaniards to "cacao" and changed by the English to "cocoa."

The process of making the beverage was long kept a secret in Portugal and Spain, where the new Mexican drink at once became fashionable, and exorbitant prices were charged for it. In England, also, it remained for a long time among the luxuries of the wealthy, even after the use of tea and coffee had become common.

Cocoa and chocolate were first made in the United States in 1765, and the demand here is now so great that immense plantations have been put out in Trinidad, Ecuador, Brazil, Venezuela, Santo Domingo, and other parts of tropical America.

The cocoa tree grew wild in Central America and South America and was cultivated in Mexico and Peru long before the coming of Columbus. It is a small tree a dozen feet or more high, with evergreen leaves and waxlike flowers which appear in clusters on the main trunk or larger branches, so that the fruits are attached directly to the older parts of the tree rather than to the tips of the younger branches.

The fruit, which ripens in from two to four months, is melon-shaped, nearly a foot long, yellowish-brown or purplish in color, and marked with about ten ribs. The seeds, or beans, are shaped like almonds and are light-colored when fresh but change to reddish-brown after drying or curing. From twenty to forty good seeds are found in each fruit.

The cocoa beans of commerce are obtained from different sources, grown on different varieties of cocoa trees, and the brands are blended as is done with coffee. Not only are there several distinct varieties of the common cocoa tree, but there are other *species* of cocoa trees in cultivation. Probably the best cocoa in Mexico is obtained from the narrow-leaved cocoa tree, *Theobroma angustifolia*, grown in Chiapas; while *Theobroma pentagona*, so named because of its large five-ribbed fruits, is even more widely known and cultivated in Nicaragua and several other cocoa-producing regions.

Cocoa is grown in rich, moist, hot lowlands, the trees being planted about twelve feet apart. They are usually shaded by other trees planted near, but, where rains are frequent, shading has been found unnecessary and the practice is being discontinued. Seedling trees have been generally used, making the crop variable and uncertain, but grafting has now been found practicable.

All parts of the cocoa tree are subject to pests. Cankers attack the roots and trunk, borers and other insects mutilate the wood and bark, and the fruits decay from various causes, especially when injured by rats, squirrels, or birds. Hurricanes strip the trees readily because the pods are heavy and attached by slender stems.

The trees begin to bear when four years old and yield crops for thirty years or more. There is no stated season when the fruits ripen, but it is customary to harvest the crop twice a year, in midwinter and midsummer. In Venezuela, December and June are the best months. The mature pods are cut from the trees with knives attached to the ends of long poles and piled in heaps on the ground. They are then opened and the seeds removed and carried in baskets to the curing stations.

The sweating, or curing, process requires about two days, during which time a kind of fermentation takes place that greatly improves the quality of the beans. They are then dried in the sun and sent to market.

On arrival at the chocolate factories, the crude cocoa beans of commerce are first carefully roasted to bring out their best flavor; then cracked and fanned to remove the thin shell which surrounds each individual bean; and finally blended, ground and molded into cakes of bitter chocolate.

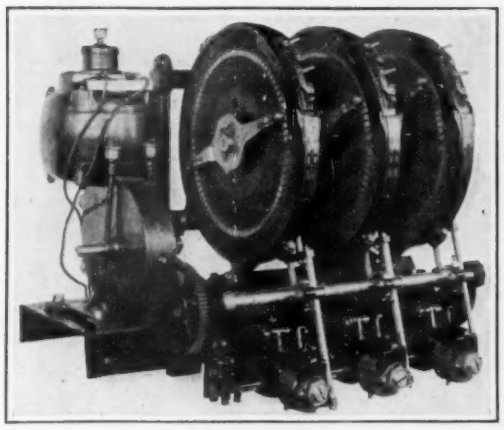
To make other forms of chocolate, sugar, milk, powder, spices, nuts, etc., are mixed with the plain chocolate and molded into the shapes desired. Breakfast cocoa is simply the powdered cocoa bean, from which some of the oil or fat has been removed. This fat, known as cocoa butter, is used in chocolate creams and other candies, as well as in the manufacture of cosmetics.

Above: A cacao plantation in Ecuador. *Below:* A chocolate factory in Ceylon.

After the cacao bean leaves the tree on which it grows

Cellulose in Rubber Goods

IN Technologic Paper No. 154 of the Bureau of Standards, just issued, a method is presented which is readily applicable to the determination of fabric in rubber sheeting, raincoat materials, water-proofed fabrics, spread goods, frictioned and calendered fabrics in general. The results which are obtained by this method have been found to be accurate, by analysis of known compounds.



This dimmer apparatus serves to vary the colored lighting effect of a show window

Stealing the Theater's Lighting Effects for the Show Room

THE artistic colored lighting effects produced in theaters by regulating the intensity of the various colored lights by means of dimmers have been adopted by a New York clothing establishment to aid in the display and sale of feminine apparel.

By means of six electric push buttons set flush into the wall of the display room, the salesman can regulate the lighting for any desired color or intensity. This automatic control from push buttons is accomplished by using three lighting circuits, the lights of each circuit representing one of the three primary colors. It is evident that any color in the solar spectrum can be produced by the proper blending of these three colors.

The brightening and dimming of each color is produced by three dimmer plates, operated independently of each other by an electric motor, one plate being provided in each of the three color circuits. Placed under each dimmer plate is a pair of electro-magnets, the coil of each magnet being connected to one of the push buttons. An armature, which normally hangs free between the magnets of each pair, moves forward or backward when attracted by either magnet. This movement of the armature closes a switch and starts a small motor, which is geared to a driving shaft running the length of the dimmer bank. The attraction of the armature to one of the magnets also causes a rack to engage with a pinion on the driving shaft, thereby transmitting the rotating motion of the shaft to the dimmer arm, and brightening the lamps of that color circuit. The energizing of the other magnet by depressing the other push button attracts the armature in the other direction and engages the shaft pinion with a rack parallel to the first, and which revolves the dimmer arm in the other direction, thereby cutting in resistance and dimming the lamps. The lamps of any circuit increase or decrease in brightness only while the "bright" or "dim" button of that circuit is depressed. Upon releasing the button the light remains stationary. Two magnets, an armature, two parallel racks and a pinion on the driving shaft are provided for each dimmer plate. The rate of dimming allows about twenty seconds to dim the lamps of any color from full "on" to "out."

The importance of showing a garment with the proper color setting is fully recognized by clothing salesmen, the color desired depending on the color and character of the goods of which the gown or suit is composed. This dimmer bank is proving itself a valuable addition to the sales force, and at the same time does not increase the duties of the salesman, who has the complete control of color at his finger tips.

Something New in Electric Furnaces

THERE has been developed an electric furnace of the muffle type, which is designed to meet the demand for a durable, economical and convenient furnace for temperatures up to 850 degrees C. for baking vitreous enamel, hardening and tempering tools, dies, etc.

The device consists of the furnace proper with a control panel mounted on top, at the front. The furnace is very strongly built, but small enough to be placed anywhere that will prove convenient. The heating element, which is mounted on the outside of the muffle, and covered with compound, is so placed as to give a very even distribution of heat throughout the inside. The element is divided so that it is possible to get two degrees of heat, for convenience called low and high heat. The former is used to give a high initial heat so that the maximum temperature can be reached quickly, in an hour and three quarters to be exact, and the latter is sufficient to maintain this temperature. The muffle is mounted on a strong steel casing, and the walls, door, etc., are thoroughly insulated, thus preventing loss of heat from radiation.

The control panel, which carries the necessary apparatus for controlling the furnace, is equipped with a main line switch, a double throw switch for high or low heat, and a red pilot lamp which acts as a warning to the operator when the furnace is on high heat. There are connections at the side of the panel for connecting rheostats when temperatures as low as 300°C. are desired. By this arrangement a very good control of the temperature is assured, and, due to the pilot lamp, there is very little excuse for the destruction of material due to carelessness, or inability on the part of the operator to tell what heat is on.

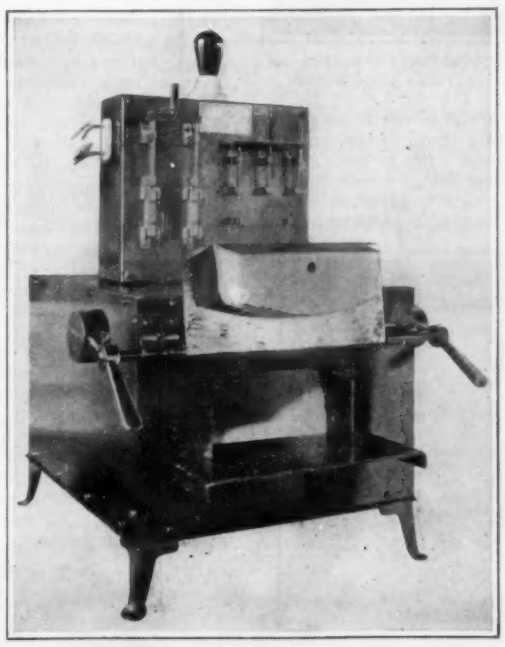
The furnace is further provided with a shelf in front for the convenience of the operator, and the door is equipped with counter weights to keep it open. The high heat necessitates 4 kw. to bring it up to 850, and the ordinary running temperature only takes 1.8 kw.

Has the Hose Coupling Problem Been Solved?

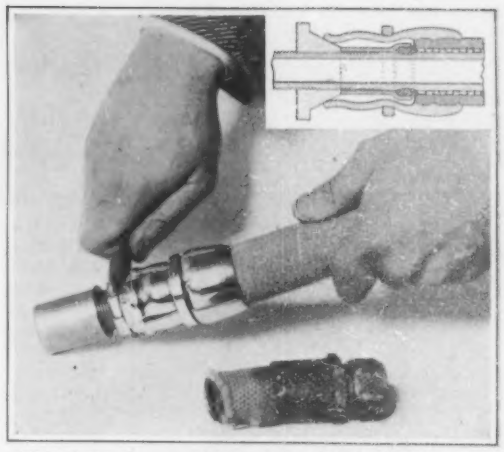
THERE are many millions of feet of hose manufactured and sold every month in the United States, and consequently the demand for a practical clamp and coupling is increasing. Considering the various plys

A complete and accurate test of automobile electrical equipment can be made with this testing cart

and thicknesses of hose walls, one can appreciate the variety of clamps needed in the past. Another disadvantage of the majority of clamps in use is that they are drawn together by the means of bolts and nuts and other obstructions which in many cases cause the loosening of the clamp. In order to overcome this, couplings have been constructed which are permanently connected with the hose. The re-use of such permanently-connected clamps necessitates special equipment, and, in fact, when the hose breaks in many cases both hose and clamp have to be sent back to the manufacturer to be rejoined. Permanent couplings for metal-lined hose have so far failed to prevent the leakage of gasoline at the hose-end.



This small furnace is designed for temperatures up to 850 deg. C.



New hose clamp which is claimed to be leak-proof, and the old-type hose it is replacing

A New York inventor, John A. Weis, has developed the ingenious hose clamp shown in the accompanying photograph and drawing. This clamp can be used to grip various thicknesses of hose walls of any standard sizes. Having no projections, it will not shake loose if exposed to vibration or otherwise. It makes an ideal coupling for hose used with pneumatic tools in mines, quarries, etc., or wherever the hose has to be dragged over the ground. All that is necessary to fasten the coupling to the hose is an ordinary wrench, therefore this coupling can be used over and over again.

By the use of the new coupling the leaking of gasoline in metal-lined hose is said to be absolutely prevented, as shown in detailed drawing. All these advantages are due to the new and novel system of employing leverage to the hose coupling.

Bringing the Testing Equipment to the Automobile

BECAUSE the various electric circuits on the present-day automobile give more trouble and present problems which sometimes baffle all except the most expert electricians, a Chicago manufacturer has recently perfected a complete portable electric service station. Due to its portability, the apparatus may be wheeled across the sidewalk to the vehicle at the curb so that it is not necessary to bring the car into the garage. It is thus a testing station on wheels.

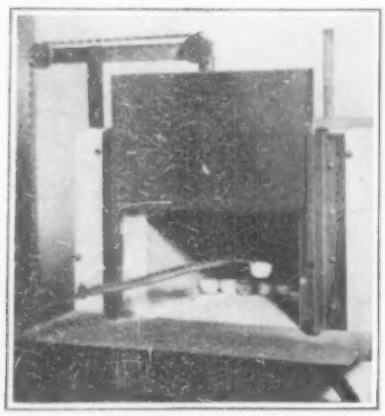
The equipment of the device is such that the following tests can be made: Battery test; magnetism of Ford flywheel magnets; condition of starter and generator; imperfect spark plugs; fuses; Ford or other coils and lighting and ignition circuits. The various instruments mounted on the cart are shown in the accompanying illustration.

A New Lamp for Photomicrographic Work

A NEW lamp outfit for photomicrographic work, which is said to be very convenient for metallographers, was recently described by Alexander Silverman, of the University of Pittsburgh. The lamp is a ¼-inch tube of colorless or blue glass, partly silvered, which is bent to a circle of 1½-inch external diameter. The single tungsten filament of the lamp can be run, for visual work, at 0.7 ampere and 9 volts for about 900 hours; or at 0.9 ampere and 13 volts for 150 hours for microscopic work; or at 1.02 ampere and 18 volts for 8½ hours. The last conditions are suitable for photographic work with exposures of 15 seconds on an average. The light is reflected conically from the circular source to the portion of the object under examination. The lampholder is ring-shaped; three iris-like fingers extend inward from the ring to clamp the holder to the objective; the lamp may also be attached to the tube of the microscope, and the objective raised or lowered inside the tube; the lamp is thus maintained at a constant distance from the object, and as the lamp surrounds the objective, reflected rays only pass into the microscope tube, and the eye is not strained. The illumination is said to give remarkable microscopic detail. A special rheostat is provided for the current regulation, and the lamp may be connected with circuits of 110 volts or of 220 volts. The devices are patented.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts



Electric muffle in which capsules of coal are burned for test purposes

Testing Coal by Burning

"TAKE the medicine in a capsule," is the advice of your physician; determine the percentage of ash in the coal you burn for domestic purposes and in manufacturing establishments by using a porcelain capsule, is the suggestion of a scientist of the U. S. Bureau of Mines. So, you see, a capsule is a handy thing to have around.

Ash in the residue of dry coal is revealed from the moisture determination. The porcelain vessel containing the residue is deposited in an electric muffle and slowly heated until the waste matter is driven off. Slow heating avoids coking of the sample of coal; also rapid heating has a tendency to explode the gas generated and portions of the ash disappear.

Combustion in the electric muffle is continued at a temperature of 750 deg. Centigrade for sixty minutes. Then the capsule, with its contents, is removed from the muffle, cooled and weighed, after which it is replaced in the electric container, heated for another half an hour, cooled and weighed again. If there is no difference in the weight of the first and second tests, the sample is constant, and the weight of the capsule is deducted from the last weighing. The weight of the capsule and ash minus the weight of the capsule, multiplied by 100 will reveal the percentage of ash in the coal.

So if you discover that the fuel you use is too bulky and contains an excess of ash, place the blame on the scientist whose precision weighing apparatus may have experienced an off-day when your coal was tested.

Arms and Stretchers That Protect the Would-Be Automobile Victim

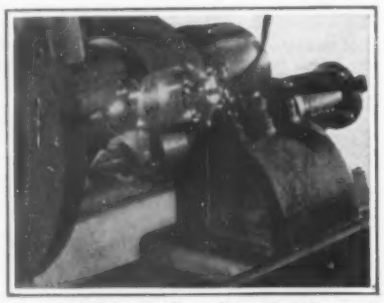
AN inventor, impressed by the large number of victims of street cars and automobiles, has developed the ingenious if somewhat complicated device shown in the accompanying illustration. This device, which may be fitted to any automobile, is provided with two canvas stretchers and a pair of arms.

The *modus operandi* of this protective device is briefly as follows: As the victim is struck by the front guard rail of the automobile, the driver presses a button which releases the mechanism. Then a canvas curtain drops over the radiator, another curtain stretches out in front and under the victim, and one of the side arms swings over and prevents the victim from falling. We are assured that the device functions flawlessly and offers no little protection to the would-be victim. But the fact remains that this device is bound to be expensive, because of its manifold intricacies; furthermore, who wants to burden his automobile with all the paraphernalia which this device represents?

More Power for the Bicycle by Rocking the Handlebars

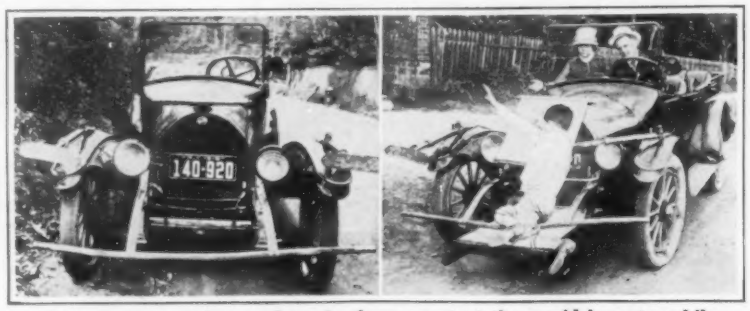
AT a recent exposition held in Brussels, Belgium, there was exhibited for the first time the odd bicycle shown in the accompanying illustration. This bicycle, while possessing the usual chain drive for the rear wheel, has a front-wheel drive in the form of a simple chain.

The handlebars of this bicycle are arranged so as to be raised and lowered.



A motor-driven nib takes the place of the diamond in truing grindstones

and in so doing the power is transmitted by means of a chain to the sprocket on the front wheel. The upward stroke of the handlebars brings a pull to bear on the chain, which is attached to the frame at one end and to part of the handlebars at the other, and this pull gives power to the front wheel. On the other hand, the lowering of the handle bar causes the chain to return to its original position, due to the freeing of the sprocket wheel on the shaft of the front wheel. Thus every upward pull is a power stroke, so to speak, while the downward push is an idle stroke. It is said that this double-wheel-drive bicycle is unexcelled in hill climbing, and that the handlebars can be worked in conjunction with the usual pedals to the best advantage.



Two canvas stretchers and a pair of arms protect the would-be automobile victim, as shown

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Rocking the handlebars up and down serves to drive the front wheel of this bicycle

Making the Grinding Wheel True

FIFTEEN years of constant practice and steadily mounting experience in grinding have served Ferdinand J. Hohnhorst of Covington, Ky., to good stead. Indeed, this invaluable foundation has been the direct means of his grinding wheel truing device, which is shown in the accompanying illustration, mounted on a cylindrical grinding machine on the foot stock center.

The device in question is now being manufactured and offered primarily for the purpose of eliminating the excessive cost of the commercial diamond, which, until the present invention, has afforded the only practical means of accurately truing grinding wheels. The present device, it is claimed, will true up a wheel as accurately as any diamond and will produce a surface free from diamond cuts.

The device consists of a small electric motor, as shown, with ball bearings throughout, and a small specially prepared abrasive nib 5/8-inch diameter and 1½ inches long, which is held in a small chuck as shown in the photograph. The speed of this little machine is 10,000 revolutions per minute, and the nib serves to grind the surface of the grinding wheel.

A Phonograph That Plays an Hour at a Time

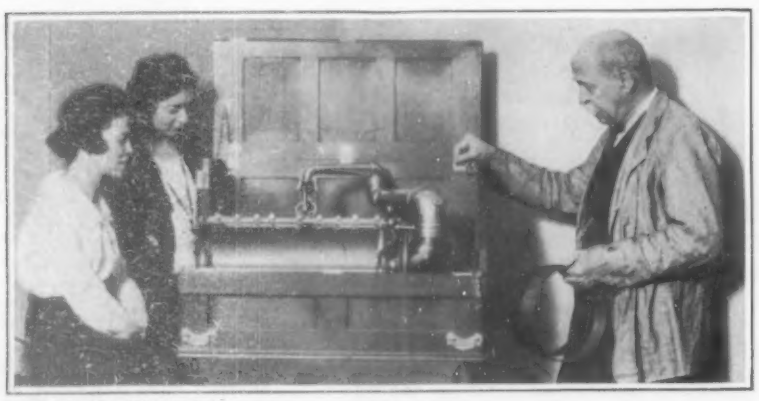
BY making records as interchangeable sections fitting on a common mandrel, George W. Bowers, a mechanical and consulting engineer of Boston, Mass., has introduced a new phase in phonographic music. Whereas the average phonograph does not handle records larger than 12 inches in diameter, with a playing time of four minutes, Mr. Bowers has a phonograph which plays for an hour without a break.

As will be noted in the accompanying illustration, the new phonograph makes use of an exceptionally large mandrel on which records, in the form of large cylinders of narrow width, are placed side by side. The needle or stylus passes over one record and right on to the next without a break, according to the inventor. In this manner the machine can be made to play for one hour, if desired; or, again, it can be adjusted to stop automatically at any predetermined time or spot.

The tone-arm arrangement of this machine is as ingenious as it is interesting. It permits the reproducer to cover the entire length of the mandrel without a hitch. The reproducer is arranged to play the hill-and-dale cut records which system, in this case, is far simpler to accommodate than would be the lateral-cut system, which predominates in the usual disk records.

Transportation, Pleasure and Exercise All in One

FROM England comes the latest idea in vehicles shown in the accompanying illustration. This "scooter" is designed very much along the lines of those used by youngsters in our country, but instead of being propelled along by an occasional push with the foot, it is propelled by working the steering handle back and forth. The vehicle here shown is provided with heavy pneumatic tires and is in every way built to give the utmost comfort and wear to the user. It is said that this vehicle affords rapid transportation, pleasure and exercise, all in one.



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This phonograph, by means of cylindrical unit records, can play for one hour without a break

Working the steering handle back and forth propels this British "scooter" along

FAIRBANKS-MORSE

The "Z" Engine Dominates the Farm Engine Field

YOU need look no further than the Fairbanks-Morse "Z" Engine for an example of the service this great house has rendered to agricultural development. Here, too, you will find the product always approaching the goal reflected in the Fairbanks-Morse Quality Seal.

For no *ordinary* engine would meet the farm power requirements of more than a quarter million users. Years of unceasing research—hundreds of thousands of dollars spent in perfecting manufacturing processes—the efforts of thousands of skilled engine builders—all have gone into the "Z" to make it what it is today.

This sturdy engine has helped revolutionize farming methods. It has released countless farm hands for the productive work of feeding the world. Its uses are as varied as the applications of power itself. Its dependability is a by-word wherever the "Z" is used.

The dominant position it holds today in the farm engine field is a reward justly earned. For it, too, must merit the Mark of Quality by which all Fairbanks-Morse products are gauged.

Our products include Fairbanks Scales—oil engines—pumps—electric motors and generators—railway appliances and coaling stations—farm power machinery, such as "Z" engines, lighting plants, water systems.

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World-wide distribution through our own branches and representatives

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GET *more light* in its cheapest form—light reflected from white glistening factory walls.

Cemcoat is the durable mill white which multiplies the natural and artificial light by reflecting it from wall to wall, wall to ceiling and so throughout the room.

Are your factory interiors Cemcoated or are you losing this *additional light* which employees need to get out full production at a time when more production is the national need?

Cemcoat

is cheaper than common paints because it lasts much longer, holds its gloss and whiteness, and can be washed without deterioration.

Cemcoat is furnished also Flat or Eggshell and in colors.

Write us for testimonials from leading manufacturers who have "painted light" on their walls and now enjoy more production and more profits.

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LAPIDOLITH
makes old or new concrete floors dust-free and wearproof by chemical action. Just flush it on.
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FOR WOODEN FLOORS
the modern wood preservative, gives new life to old or new wooden floors.

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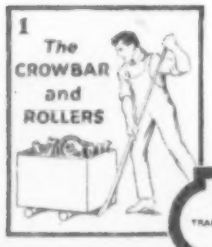
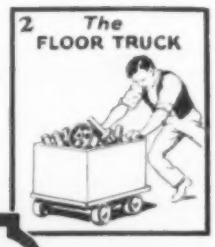
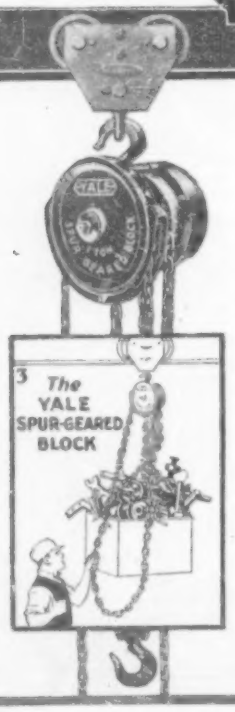




TRADE YALE MARK



1920 INTER-PLANT TRANSPORTATION

A Yale Spur-Geared Chain Block suspended from a Trolley, and an I-Beam System

QUICKLY and with little effort heavy materials can be moved from one department to another via the overhead I-Beam route.

An overhead I-Beam track system will save your floors and economize aisle space.

Roller and hand truck methods are slow and expensive.

A Yale Spur-Geared Block suspended from a Trolley and I-Beam system requires less operating effort, will make more trips per hour, and carry more material per trip with increased safety to the operator and the load.

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The Yale & Towne Mfg. Co.
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Pooling Our Power

(*Continued from page 618*)

4,000 horse-power in boiler equipment. Instead of those numerous, wasteful, dissociated plants, all of the essential power is furnished today by a single central electric station depending upon a boiler capacity of only 500 horse-power! Wire conductors have supplanted the erstwhile steam mains, and the diversified energy demands of the several properties are thus satisfactorily taken care of, and all because the power need at any one time does not exceed the central station's resources.

But it would not suffice if, in establishing a super-power zone, the railroads continued to depend upon the steam locomotive as a tractor. To obtain the greatest benefits, it would be necessary to electrify all of the trunk lines and those of the feeders where the density of traffic would warrant electric haulage. The steam locomotive is not an example of fuel economy, gaged by modern standards, and from the nature of its get-up this engine requires a pretty high grade of coal. Further, the locomotive must expend a considerable measure of its tractive effort in dragging along behind it a tender loaded with coal and water. Mr. Murray states that the steam passenger locomotive calls for 2 pounds of coal for each pound burned in energizing the electric locomotive; the steam freight engine is 1½ times more costly in the matter of fuel; and the yard or shifting locomotive when driven by steam consumes 4 pounds of coal against the one pound needed where equivalent energy is generated for the electric tractor. These data are based upon the records of a central power station, built some years ago, for the electrified section of one of our great eastern railways.

As originally equipped the plant had eight 5,000-kilowatt generators, and at that time the heat efficiency of the installation was 8 per cent. The nation is about to be modernized by substituting a single 40,000-kilowatt machine; and the efficiency should be quite 18 per cent! Therefore, the relative figures in the preceding paragraph should properly be correspondingly modified to the added credit of electric traction. It should cause no surprise, then, to be told that it is possible to provide all of the motive force needful within the proposed zone by a carefully coördinated plant capacity of 5,500,000 horse-power where we now have stationary and mobile steam plants totalling 17,000,000 horse-power! This would entail a yearly saving of fully 30,000,000 tons of coal, which, at $5 a ton, would mean an annual economy of $150,000,000.

Another prominent man in the engineering world, Mr. Edwin Ludlow, emphasizes the economic necessity of doing away with steam traction as far as practicable on our railways. As he explains: "The railroads now burn 28 per cent of the total output of the bituminous mines; with electrification this would be reduced to 10 or 12 per cent. Freight congestion and car-supply troubles also would be solved, as the central power plants in the coal-producing states could be located at a group of mines, requiring only a minimum of switching service. Coal too high in sulphur for safe storage could then be burned as produced, and the mines kept in continuous operation."

Car-mileage service in the transportation of coal could, in this way, be enormously reduced, and the vehicles applied to the hauling of vast quantities of other freight—doing this without adding at all to track congestion. It is authoritatively stated that electric energy in blocks of quite 500,000 horse-power can be distributed over a radius of 300 miles from the source of generation. Heretofore, the "corona effect," induced by high-voltage on comparatively small copper conductors, has occasioned heavy losses on long lines and, therefore, seriously curtailed commercial distribution of current. But by the substitution of cheaper and larger aluminum conductors this loss has been materially lessened and the zone of transmission widened.

Ultimately, the super-power plan embraces the establishment of monster electric generating stations at the mine mouth or within easy reach of the pits, and it will be entirely feasible to consume there grades of coal that are normally unmarketable and, of course, quite unsuited to burning under the boilers of steam locomotives. What is more, these master plants will require but a minimum of attendance owing to the mechanical facilities which will make the feeding of the fuel substantially automatic. Clearly, the carrying out of this revolutionary scheme of general electrification will greatly diminish the cost of machinery maintenance; and it would be possible to bring about a marked consolidation of trains through the greater effectiveness of the electric tractor. It is believed that these two departments of economy will lead to an additional yearly retrenchment of $150,000,000 in the projected super-power zone, while speeding up our productive capacity, amplifying our passenger and freight transportation, and widening the ways in which electricity may serve our domestic comfort and convenience.

It is undeniably true that the initiation of the super-power plan would require very large outlays of capital, but the expenditures would be amortized in a few years; and once established the system would bring benefits in its train that are difficult to grasp and visualize in their entirety at the present time. It would effectually prevent a recurrence of the conditions that confronted us during the crucial period of our participation in the World War. The citizens of our Eastern States within the section in question do not know it generally, but we came precious close to an industrial collapse and a transportational stalling that might have provoked the very gravest of consequences. With a super-power zone called into being in our North Atlantic region, then kindred methods would be applied elsewhere throughout the country whenever circumstances warranted. Mr. Murray has shown how we may in the decades to come hope vastly to augment our productive activities while cutting down to an amazing extent our annual consumption of coal. Needless to remark, he contemplates, wherever possible, the fullest utilization of our waterpower resources.

Two Engines for One

(*Continued from page 619*)

tractor tenders for freight engines were running on the Great Northern Railway (England) in the early sixties. The present writer saw many of these engines at work, and they attracted much notice, not only by the great length of their trains, but by the puffs of exhaust steam which issued from the rear of the tender.

These locomotives were designed by the late Mr. Archibald Sturrock, who, shortly before he died, presented the writer with photographs of his engines. Mr. Sturrock was locomotive superintendent of the Great Northern Railway for many years and introduced some noteworthy improvements in railway machinery. Among them he conceived the idea of utilizing the weight of the tender for traction, and built about fifty locomotives which carried cylinders and driving wheels in the tender frame. A photograph of a complete engine and a line drawing of one of the tenders are shown in the accompanying illustrations. The weight of the tenders loaded was about 57,000 pounds. The middle axle was cranked and driven by a pair of inside cylinders 12 inches diameter by 17 inches stroke. The wheels were 48 inches diam-

(*Continued on page 632*)

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WAR SURPLUS PLANT SITES
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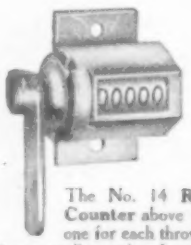

The No. 14 **Ratchet Counter** above registers one for each throw of the lever, recording number of machine operations. Supplied with outside stops which regulate the throw of the lever, and having return spring action which automatically returns the lever into position for the next count. The lever is adjustable, allowing the counter to be used at any angle. Price, $2.25
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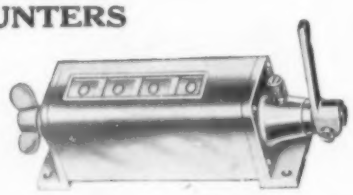

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Two Engines for One

(Continued from page 630)

eter and were connected by outside coupling rods. Steam for the tender engine was drawn from the main engine boiler and was controlled by a separate throttle valve. It was conducted to the tender cylinders through a pipe (visible on the photograph) from the outside of the steam dome. In practice this pipe was found sufficiently flexible without the intervention of compensation joints. The valve gear was the ordinary Stephenson link-motion worked by a separate reversing lever on the tender. The exhaust steam was delivered into a tubular condenser which was surrounded by the water in the tank, and what remained uncondensed passed away through two short outlet pipes at the rear of the tender. These and other details are clearly shown in the drawing.

The tractive effort of these tenders was about 5,600 pounds. The engines to which they were attached were the ordinary English freight locomotives of the period, but their heating surface was slightly increased to supply the necessary steam to the tender cylinders. The leading dimensions of the engines were: Cylinders, 16 inches diameter by 24 inches stroke; driving wheels, 60 inches diameter; total heating surface, 1,082.26 square feet; weight in working order, 73,000 pounds.

The tractive effort of the engine was about 11,264 pounds, which, added to that of the tender, made a total drawbar pull of 16,864 pounds.

The hauling power of these steam tender locomotives was nearly double that of the ordinary engines of the same class; for on a level road they drew sixty loaded cars, while the latter could pull only thirty-five cars on the same track.

Although a mechanical success, they were in advance of their time, for the trains they hauled were too long to be handled with convenience, since the length exceeded that of the side tracks. Moreover, on down grades the longer trains were difficult to control with the inadequate braking power of fifty years ago. Another reason for their failure was that the tender caught the dust and grit from the engine, making the repair bills heavy.

Finally, the engine men complained that they had practically two engines to care for instead of one, and their disfavor doubtless contributed to the want of success of these tenders, which, as Zerah Colburn (a great authority on locomotive engineering) said, "deserve to be remembered as a contribution to the practice of auxiliary power."

The Romance of Invention—XIII

(Continued from page 620)

war, either one of which was bigger than ordinary man size. For they wished the airplane development on the Signal Corps and for fourteen of the eighteen months of the war the Signal Corps not only attended to its business, put its own men over seas, bought and manufactured its own equipment, laid down telegraph and telephone and cable systems, kept the army in touch with itself and with this country and kept the situation in France in touch (through its own cable) with the Navy and the forces in England—but at the same time developed the airplane industry from nothing to an army of over a quarter of a million workers and from no plants at all to some of the biggest in the world, while doing such side-issue pieces of work as getting out the spruce and developing the Liberty motor.

All these activities came to a point in the office of the Chief Signal Officer. It is a small office, with a desk in it, a telephone or so, a couple of pictures—and that's all. There were no papers. General Squier didn't write any papers or letters during the war. He hadn't time, in the first place, and he didn't believe

A Wife Too Many

Into the hotel lobby walked a beautiful woman and a distinguished man. Little indeed did the gay and gallant crowd know that around these heads there flew stories of terror—of murder—and treason—that on their entrance half a dozen detectives sprang up from different parts of the place.

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It is a wonderful story with the kind of mystery that you will sit up nights trying to fathom. It is just one of the stories fashioned by that master of mystery

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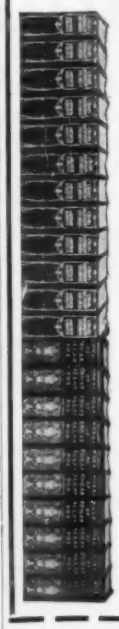

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in letters when talk would better serve. He holds that as it is the duty of the Chief Signal Officer to provide and maintain the very best methods of communication for the army, the Chief Signal Officer ought to use only the very best methods of communication himself. So that, when he wanted to tell a man anything or ask him anything or have anything told to him, he sent a messenger to the man to carry or bring a verbal communication—or used the telephone. When Mr. Hughes was conducting his airplane situation investigation, he asked for General Squier's letter file. And there wasn't any. Which General Squier rather grimly smiles about, well knowing that a lot of perfectly well meaning people get themselves into a lot of trouble by writing letters. However, it was not to keep out of possible trouble but to save time and get efficient results that General Squier used voice rather than letter. It is said that during the war no one sat down in General Squier's office but himself; but it is also told of him that his door was never shut. No one came into that office who hadn't something to say. Having said it, he didn't sit down and say it again; he got out and gave place to the next one.

But even so the day wasn't long enough. "Of course it wasn't!" said General Squier to the writer. "A day ten times as long wasn't long enough. The only way I got through was by judging which of seventeen things which had to be attended to instantly was the most important, attending to it and letting the other sixteen go, or giving them to some one else to attend to and forgetting it. There is where I was fortunate, in having the right kind of men to give things to do. I won't have a man around me whom I can't trust absolutely to do what he should do, and having him and trusting him, I could afford to forget all the things he had to do and just attend to what I had to do. Anyway, we did it. And the war is over and our part in it is finished, our report written, printed and distributed and we have forgotten it and are back on the job experimenting and trying to keep the Signal Corps a step or two ahead of the rest of the world in methods and means of communication."

Personally, General Squier is all military. His bearing is erect; he is slender, quick in his action, clips his words short, looks as keenly as he speaks and has a general air of having something to do every minute and of spending every minute doing it. But those whose acquaintance with General Squier is only of the most formal sort fail to see the underlying human side of a character which has attained such heights in two widely different lines entirely by natural gifts plus single-mindedness. General Squier is neither a military machine nor a martinet. He is very human and likable, and has a keen sense of humor, which is apt to be somewhat grim at times, and a very vivid and forceful way of illustrating his points with odd little turns of speech which make his remarks on even an abstruse subject all of human interest. Turning to the telephone on his desk while discussing the future of telephony General Squier remarked, "You'll see the day when *that* is regarded as a blacksmith's job!"

General Squier has hooked up the laboratory and the military establishment as few if any have ever done before him. Many an able administrator of Signal Corps policy and activities has been content to adapt to army use the inventions and discoveries made in the scientific world. Not so the present incumbent. A physicist of note himself, he is anything but content to have his military machine utilize only the work of civilian physicists. He believes in the laboratory as a part of the army and has the strongest of convictions that the Signal Corps should initiate as well as adapt. His military ambition is to keep his Corps some

the Center

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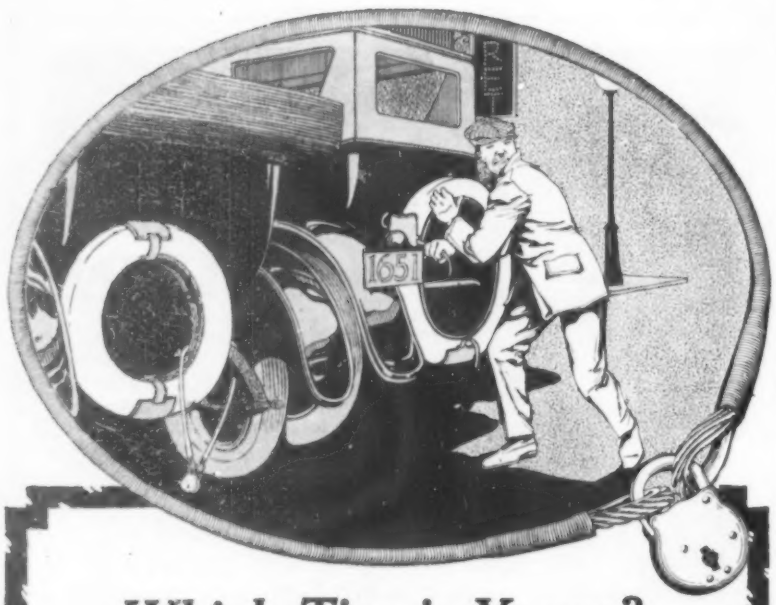

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three jumps ahead of the rest of the military world not only in communication, but in original research. To this end he not merely reviews all the work being done in the several experimental laboratories of the Signal Corps, but personally finds time for work in them, where he probably forgets his stars and decorations and sees the world of the military only darkly through the eyes of a born physicist.

Scientific men are often justly accused of a certain vagueness in human relations outside the laboratory. There is nothing of this about the general. He is concise, definite, concrete, practical in his relations with his work and his affairs. There is no touch of the visionary about him, though it would be idle to deny to him the possession of a very far vision. When he takes out a patent—and he doesn't know just how many he has taken though it is upwards of a hundred—it is for something which works, not a hope or a dream.

General Squier would be a very wealthy man from his patents if he were not a general in the United States army. His inventions are in such universal use in the wireless, telephone and telegraph world that had his powers been devoted to the same ends during a civilian career they would have undoubtedly brought him a vast amount of money. Being an officer, all his inventions, of course, are entirely free to the use of the United States Government. It appears now, however, as if a better construction of equity as well as of law will permit him to realize something of the commercial value of his work and there is a strong probability that such a decision from legal authority will permit him to receive from commercial interests some material reward for the work he has done.

To the man in the street the statement that a scientist has made important research in the domain of electro-chemical effects due to magnetism or the sine-wave system of telegraphy and ocean cabling, or invented a polarizing photochronograph, or vastly improved multiplex telegraphy, means little. To the world of communication such things mean much. So that honors have come to the military scientist, sometimes faster than he could receive them! He is a fellow of the Physical Society of London (1914), and a member of the Royal Institution of Great Britain (1912). Last year several added distinctions were given him—he was elected a member of the National Academy of Science in recognition of his contributions to science; he was awarded the Franklin Medal by the Franklin Institute of Philadelphia in recognition of his valuable contributions to physical science, his important and varied inventions in multiplex telephony and telegraphy and in ocean cabling, and his eminent success in organizing and directing the Air and Signal Services of the United States Army in the World War; he was decorated with the insignia of the Order of Knight Commander of Saint Michael and Saint George by Field Marshal Sir Douglas Haig at London; and he received the Distinguished Service Medal of the United States Army for exceptionally meritorious and distinguished services.

It is interesting to recall that General Squier, who had charge of America's airplane effort in the war for the greater part of the time, and under whom was developed the Liberty motor (which he regards as one of the great achievements of this country in the great conflict) and by whose work the wireless telephone was successfully applied to airplanes, is the same General (then Major) Squier who drew up the first specifications ever issued by any government for the first military airplane. Incidentally he can look at pictures of the first accident to the Wright plane at Fort Myer in 1908 and say, "There, but for the grace of God, lies General Squier." He was among the first of the officers taken up by Wright and it was but chance that sent one officer (Lieut. Selfridge) to his death rather than another.

General Squier has a properly assorted rainbow over his heart for the various services he has experienced. . . . Philippines, Philippine Insurrection, etc. But if they gave ribbons for laboratory service, he wouldn't have to wear a coat at all; for his service to the world of physics would then clothe him!

Putting Plants on Daylight Rations

(*Continued from page 624*)

when they are shifted to different latitudes, and may also clear up the conflicting results of variety tests and field tests conducted with the same crops but in different regions. The experiments have shown, for instance, that ragweed requires for flowering a stimulus that is afforded by the shortening of the days and lengthening of the nights. It does not come into flower until the period of daylight falls below 15 hours. In the latitude of Washington, that comes about July 1. But if ragweed seed should be taken to northern Maine and planted, the plants would not experience a length of day below 15 hours until about August 1. Therefore, they could not come into flower until after August 1, and, though the vegetative growth might be very rank, they could not mature seed before killing frosts intervened. The long days, therefore, make it impossible for ragweed to perpetuate itself in that latitude. On the other hand, plants that get their flowering stimulus from a long day could not perpetuate themselves through seed formation at the equator, where the day never exceeds 12 hours.

This principle affords the clue to the fact that many plants grow most luxuriantly near the northern limit of their range. The long northern day allows them to attain their maximum growth before the shorter day intervenes to check vegetative growth and start the reproductive process.

It may be found eventually, say the men who worked out the principle, that the animal organism, also, is capable of responding to the stimulus of certain day lengths. They believe that the migration of birds may be an illustration. Direct response to such a stimulus, they say, is more in line with modern teachings of biology than theories which assume that birds migrate as a matter of instinct.

Why the Industrial Tractor and Trailer System Makes Good

(*Continued from page 625*)

the cars the tractors showed a reduction in hauling costs of 25 per cent a ton, which today, by reason of other short cuts, has been increased to a saving of 35.244 per cent a ton.

Next came the test between the electric tractor system and the trolley car method. One branch of the elevated railroad was shut down. A four-week comparison was then made. During the first two weeks the four-wheel trailers and tractors were used and during the second two weeks elevated trolley car method was employed. At the end of the test the figures showed that a 16 per cent reduction in costs per ton had been effected through the use of the tractor and trailer system.

The tractor and trailer system has now been installed in this huge packing plant. There are sixty tractors in service, all of which are a paying investment. The plant experts figure that each machine pays for itself in a year's time. In some cases the labor of three men is saved and in others as high as seven by installing a tractor. The tractors could, if pushed to the maximum, handle each 50 tons of freight per day of ten hours. These hauls vary from 90 to 1,100 feet, but the average is about 400 feet. In

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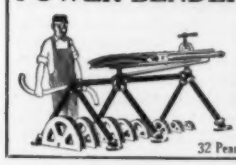

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most cases the hauls are made over level surfaces. What grades there are to contend with are short, varying from between 10 and 25 feet, the slope of which is from 2 to 10 per cent.

Most of the tractors in use at this packing plant are of one make, to simplify the operation and upkeep. A recapitulation shows the cost per week to be $58.90 for a tractor and a train of ten trailers, divided into $5.30 for overhead, $4.00 for repairs, $3.00 for power, and $36.60 for labor. The outfit handles something like 360 tons a week, and the cost per ton on this basis is 16.4 cents.

American Goods Needed in Ceylon

CEYLON, in proportion to its population, has a larger foreign trade than India. The island is fortunate in producing staple commodities which are in constant demand and the majority of which are needed for military purposes. It enjoys better shipping facilities on this account and has been able to obtain more foreign goods than countries not so well situated.

The United Kingdom naturally has the largest share of its colony's trade, and British possessions are second. Of the foreign countries exchanging their products for those of Ceylon, Japan is first, leading the United States by a narrow margin in 1916, the last year for which statistics are available.

The American Consul at Colombo reports a general shortage in Ceylon of many drugs, such as quinine, salts, sulphuric and carbolic acids, permanganate of potash, and other disinfectants. Acetic acid, used in the coagulation of rubber and obtained chiefly from Japan, has greatly advanced in price. There is a scarcity of paints, building materials, iron and steel, zinc ware, brass ware, and plated goods. Printing paper, leather goods, clothing, soaps, and glassware are among the other articles needed in Ceylon that might be imported from the United States.

Goods shipped to Ceylon must be plainly marked with the name of the country of origin to comply with the Merchandise Marks Ordinance, which has been in effect for several years. It is strictly enforced. The lack of American banking and shipping facilities, well-known handicaps to American trad extension in Ceylon, have been largely nullified by the war, but with the return of normal conditions these two factors will have a marked influence upon the maintenance or the improvement of our present position in the island's import trade. There is a real need for an American bank in Ceylon. The growing business between Ceylon and the United States, now upward of $30,000,000 annually, could be financed more satisfactorily if such an institution were established. The terms of confirmed credit, American port of shipment, now insisted upon by exporters in the United States will have to be more liberal in the future and an American bank in Colombo would facilitate transactions.

Recent Glass Research

METHODS available for determining the temperature at which glass should be annealed were tested by the Bureau of Standards, and the annealing temperatures are given for a number of glasses in Scientific Paper No. 358 of the Bureau. Determinations of the critical ranges for these glasses were also made and the results are discussed. The relation which possible transformations occurring in this range bear to the annealing procedure are especially considered. Methods for determining the length of time the glass should be held at the annealing temperature and the mode of cooling were investigated and some conclusions are given. This paper is now ready for distribution and any one interested may obtain a copy by addressing a request to this Bureau.

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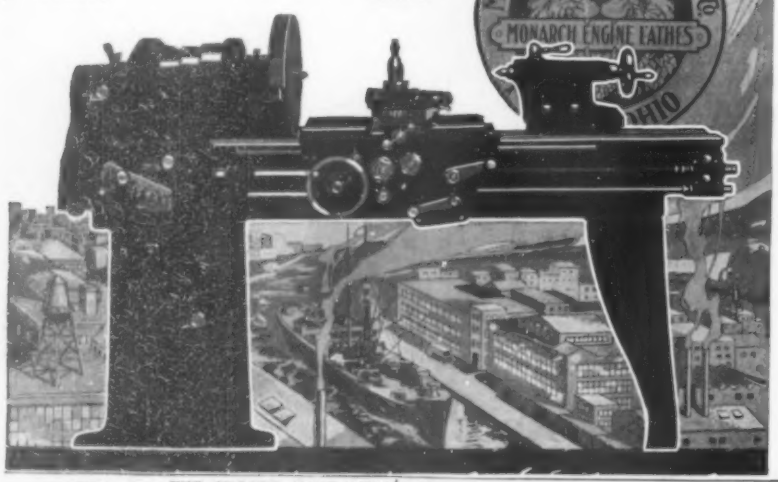

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NEW BOOKS, ETC.

THE WOMAN OF FORTY. By Edith B. Lowry, M.D. Chicago: Forbes and Company, 1919. 12mo.; 203 pp.

Dr. Lowry's books on sex hygiene are so widely and so favorably known that her latest, addressed to the woman of forty, is assured of a good reception. The miseries, even tragedies, of this period of life are shown to be largely the result of the woman's own ignorance of herself; she is taught so to improve the general health as to make the body highly resistant to lurking ills, while the mind, an important element in the phenomena of the "dangerous age," is directed into constructive channels and kept usefully busy.

LUTHY'S SCIENTIFIC HANDWRITING. Peoria, Ill.: Chas. T. Luthy. 8vo.; 233 pp.; illustrated.

If Mr. Luthy's system accomplishes half what its advocates claim, the business world will have cause for thankfulness. The failure of our school handwriting is conspicuous. The author dissects each letter into clearly comprehensible parts—his original investigation, based upon movemental, visual, and geometric principles, having taken seven years. The present published study naturally resolves itself into three parts: Execution, the basic parts of the letters, and the structure of the letters.

COMPLETE PRACTICAL MACHINIST. By Joshua Rose, M.E. New York: Henry Carey Baird and Company, 1920. 8vo.; 547 pp.; 432 engravings

The new edition of this standard work, while maintaining the form that has proved so helpful to machinist and apprentice, shows valuable additions that bring the book to date. It contains the practical details of lathe work, vise and bench work, drills and drilling, taps and dies, hardening and tempering, tool making, using, and grinding, marking out work, machine tools, and all other devices and operations of the shop worker's environment. As its users know, the volume combines both instructive and reference qualities, making it well-nigh indispensable to the library of the conscientious worker.

THE AMERICAN ANNUAL OF PHOTOGRAPHY, 1920. Vol. XXXIV. Edited by Percy Y. Howe. New York: The American Annual of Photography, Inc., 1919. Sales Agents, George Murphy, Inc., New York. 8vo.; 296 pp.; illustrated.

Thoroughly artistic, as an exposition of the progress of photography should be, this Annual is noteworthy also for its condensation of widely useful information into a half-hundred articles by leading exponents. To this appraisal may be added the formulary selected from the working methods of practical photographers. The ambitious picture-taker is assured of finding the Annual full of interest and a source of definite aid in his everyday work. The plates are exceptionally meritorious; they take us fairly well over the world, with a natural leaning toward American subjects.

THE WORLD'S FOOD RESOURCES. By J. Russell Smith. New York: Henry Holt and Company. 8vo.; 633 pp.; 144 illustrations and maps.

Dr. Smith, who was special consulting expert on the War Trade Board, and whose investigations and work in economic geography are justly held in high esteem, here gives us enlightening facts about our chief foodstuffs—grains, meats, vegetables and fish—and their sources and distribution. Food and man, and lack of sufficient food and our so-called "unrest," are topics so closely associated that the author has done well to emphasize their relationships. The result is a work in such understanding contact with our common life and its prime necessity, so illuminative of the cumulative effects of food shortage upon human affairs, that we can harbor no doubt as to its extremely valuable contribution to economic literature. Information so well put, and withal so vital, interesting and beneficial, should be eagerly sought by the reading public.

VERTEBRATE ZOÖLOGY. By Horatio Hackett Newman, Ph.D. New York: The Macmillan Company, 1920. 8vo.; 432 pp.; illustrated.

This new college textbook stresses such features of its subject as are not sharply defined by laboratory work in comparative anatomy. The treatment is broad and dynamic. The ancestral history of the vertebrate classes receives careful attention and is interestingly related to present groups, and the author makes full use of Child's axial gradient conceptions. With its fine gallery of illustrations, many of which may be combined into chart form, the work shows originality in method with numerous other points of appeal.

NOTIONS FONDAMENTALES DE CHIMIE ORGANIQUE. By Charles Moureu. Paris: Gauthier-Villars et Cie.: 1919. 8vo.; 552 pp.

Prof. Moureu's work has been well received in his own country, as is evidenced by the demand having exhausted five editions. This sixth edition, revised and enlarged, embraces the newer knowledge and theories; there are new treatments of such subjects as stereo-chemistry and radiations and, although the work is a text rather than a treatise, it broaches the general problem of the mechanism of reactions, with some consideration of contingent questions.

RADIO ENGINEERING PRINCIPLES. By Henri Lauer, B.S. and Harry L. Brown, B.E.E. New York: McGraw-Hill Book Company, 1920. 8vo.; 300 pp.; illustrated.

There is a very real demand for a text of this nature, covering the recent progress of the art of radio communication, and the authors' close contact with military radio thoroughly qualifies them for their task. The three-electrode vacuum tube perhaps holds the greatest promise for the future, and its uses as detector, amplifier, oscillator and modulator are taken up in detail. It is sufficient to say that Major General Squier expresses himself as greatly pleased with the book as covering fully and plainly, without excessive use of mathematics, the wonderful developments of this art during the war—in so far, that is, as a disclosure of these developments is at present permissible. There are marvels still in reserve.

ELECTRIC LIGHTING. By Olin Jerome Ferguson, B.S. in E.E., M.E.E. New York: McGraw-Hill Book Company, 1920. 8vo.; 243 pp.; illustrated.

Today, as the author remarks, the need for artificial light closely follows that of food, shelter and clothing; and it includes problems of efficiency and adaptability that electrical engineering is occupied in solving. The work in hand is characterized by a comprehensive study of all fundamental factors and the principles and practice following upon them. It is a textbook of textbooks, in that it includes in one volume what would otherwise have to be sought in many. Both interior and exterior lighting are dealt with, and due regard is paid to economic values and the fitness of the various systems to particular requirements.

THE MAKING OF HUMANITY. By Robert Briffault. New York: The Macmillan Company, 1919. 8vo.; 371 pp.

In a striking and original manner, the author reviews the means and tasks of human evolution, the genealogy of European civilization, and the evolution of moral order. In his revolt against the self-satisfied textbook, he may occasionally go too far in the opposite direction, but as a whole the reasoning is well-balanced and the conclusions sound. We are given new lights on history and psychology, and perhaps the most out-looming chapter is that on "Custom-Thought and Power-Thought." The work is a sustained piece of reflective writing with a powerful appeal to the thoughtful mind.

SOME WONDERS OF MATTER. By the Right Rev. J. E. Mercer, D.D. New York: The Macmillan Company, 1919. 8vo.; 195 pp.

The author has the gift of putting difficult explanations into simple Anglo-Saxon words. Matter is distinguished from non-matter by the facts that it "lasts; takes up room; and resists." Thus the young reader is not posed by big terms, and the older reader gets a sense of freshened vision. We find our confused ideas of the atom, electrons, and radio-activity falling into orderly arrangement, and our interest is quickened into eagerness that will lead us to more advanced studies.

THE BOOK OF THE DAMNED. By Charles Fort. New York: Boni and Liveright, 1919. 8vo.; 298 pp.

The "damned" are not individuals, but incidents, such as the apparent precipitation from the skies of red rain, animal matter, frogs and fishes. These occurrences are damned by the silence or the futile theories of science; indeed in condemning science, Mr. Fort becomes *fortissimo*. He has spent much time in collecting circumstantial reports of these remarkable occurrences, and in drawing from them still more remarkable conclusions, preferring to call the red rain blood, the animal matter the remains of aerial dragons, and the frogs and fishes visitors from some dark world above our heads.

SUCCESS WITH HOGS. By Charles Dawson. Chicago: Forbes and Company, 1919. 8vo.; 268 pp.; illustrated.

The Department of Agriculture tells us that the farm value of the pig advanced, from 1912 to 1919, about 175 per cent, which is greater than the advance in the average beef animal; in the same period, the number of swine on our farms increased from 61,000,000 to 76,000,000. So that this broad, practical treatise on the correct feeding, care and treatment of swine should simplify the problems and practice of the hog-raiser, for its writer has had the widest experience and the benefit of association with other authorities on the subject.